TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE.

1873.

VOL. VI.

EDITED AND PUBLISHED UNDER THE AUTHORITY OF THE BOARD OF GOVERNORS OF THE INSTITUTE,

BY

JAMES HECTOR, M.D., F.R.S.

Issued June, 1874.

WELLINGTON:
JAMES HUGHES, PRINTER, LAMBTON QUAY
TRUBNER & CO., 60, PATERNOSTER ROW, LONDON.

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AM. ANTIQUARIAN SOCIETY, WORCESTER, MASS.

TRANSACTIONS

AND

PROCEEDINGS

OF THE

Royal Society of New Zealand, Wellington

NEW ZEALAND INSTITUTE,

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1873.

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VOL. VI.

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BY

JAMES HECTOR, M.D., F.R.S.

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Issued June, 1874.

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Page 144, *transpose* lines 21 to 33, commencing "Irides grey" down to "red-tailed Huia," to after line 6 on same page.

ERRATA ET ADDENDA.

PAGE
64, in the table under *Aquila audax*, *for* 8·20 *read* 8·02.
64, ,, ,, ,, ,, and p. 65, line 9, *for* 22·03 *read* 21·85.
66, ,, 8 from bottom, *for* proximal *read* procnemial.
69, ,, 4, *for* ridges *read* calcaneal ridges.
70, ,, 3 from bottom, *for* shorter *read* stouter.
75, in the table, *for* Metatarsus *read* Fibula, and insert "5–6. Metatarsus of *H. moorei.*"
76, ,, ,, *transpose* Weight *and* Bulk.
85, line 14, *for* curved *read* convex.
130, ,, 13 from bottom, add "He has since repeated this error in his 'Catalogue,' by stating (p. 11) that *Certhiparus novæ-zealandiæ* inhabits both islands."
183, ,, 3, *for* January, 1874, *read* July, 1873.
319, ,, 22, *for* 6,000 *read* 1,000.
320, ,, 15, *for* Reid's *read* Ross'.
323, in the second table, *for* Liang *read* Leaning.
331, line 14, *for* of *read* by.
334, ,, 22, *for* Liodon *read* Leiodon ; also on pp. 336, 338.
350, *for* Mauisaurus latibrachialis *read* M. brachiolatus.
385, line 13 from bottom, omit the second "by."
xxxvii., in the table, line 8, for the first "munga" *read* manga; for the second *read* mangu.
xliii., line 19 from bottom, *omit* Mu.
xliii., ,, 10 ,, ,, *under* Kau *add* Mu.
lii., ,, 32, *for* dun *read* dan.
liv., ,, 12, *for* of *read* on.
lv., ,, 8 from bottom, *for* ubah *read* uba.
lvi., ,, 12 and 19, *for* Crawford *read* Crawfurd.
lxi., ,, 26, *for* karana *read* karaua.
lxvi., ,, 5 from bottom, *for* Garlandinea *read* Guillandina.
lxxiii., ,, 12 ,, ,, *for* oullana *read* orellana.

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NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND INTITULED "THE NEW ZEALAND INSTITUTE ACT, 1867."

BOARD OF GOVERNORS.

(EX OFFICIO.)

His Excellency the Governor. | The Hon. the Colonial Secretary.
His Honour the Superintendent of Wellington.

(NOMINATED.)

Hon. W. B. D. Mantell, F.G.S. (retired 1868), Hon. Col. Haultain (retired 1869), Jas. Edward FitzGerald, C.M.G. (retired 1871), Charles Knight, F.R.C.S. (retired 1872), Sir David Monro, W. T. L. Travers, F.L.S., Alfred Ludlam, James Hector, M.D., F.R.S., Hon. G. M. Waterhouse, Hon. E. W. Stafford.

(ELECTED.)

1873.—His Honour William Rolleston, B.A., His Honour Mr. Justice Chapman, Captain F. W. Hutton, F.G.S.

1874.—His Honour William Rolleston, B.A., His Honour Mr. Justice Chapman, James Coutts Crawford, F.G.S.

ABSTRACTS OF RULES AND STATUTES.

GAZETTED IN THE "NEW ZEALAND GAZETTE," MARCH 9, 1868.

SECTION 1.

Incorporation of Societies.

1. No Society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act, 1867," unless such Society shall consist of not less than twenty-five members, subscribing in the aggregate a sum of not less than fifty pounds sterling annually, for the promotion of art, science, or such other branch of knowledge for which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the Chairman for the time being of the Society.

2. Any Society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the Members of the said Society shall at any time become less than twenty-five, or the amount of money annually subscribed by such Members shall at any time be less than £50.

3. The bye-laws of every Society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of its annual revenue in or towards the formation

or support of some local public Museum or Library ; or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the Museum and Library of the New Zealand Institute.

4. Any Society incorporated as aforesaid which shall in any one year fail to expend the proportion of revenue affixed in manner provided by Rule 3 aforesaid, shall from thenceforth cease to be incorporated with the Institute.

5. All papers read before any Society for the time being incorporated with the Institute, shall be deemed to be communications to the Institute, and may then be published as proceedings or transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications :

Regulations regarding Publications.

(*a*) The publications of the Institute shall consist of a current abstract of the proceedings of the Societies for the time being incorporated with the Institute, to be intituled, "Proceedings of the New Zealand Institute," and of transactions comprising papers read before the Incorporated Societies (subject, however, to selection as hereinafter mentioned), to be intituled, "Transactions of the New Zealand Institute."

(*b*) The Institute shall have power to reject any papers read before any of the Incorporated Societies.

(*c*) Papers so rejected will be returned to the Society before which they were read.

(*d*) A proportional contribution may be required from each Society towards the cost of publishing the proceedings and transactions of the Institute.

(*e*) Each Incorporated Society will be entitled to receive a proportional number of copies of the proceedings and transactions of the Institute to be, from time to time, fixed by the Board of Governors.

(*f*) Extra copies will be issued to any of the Members of Incorporated Societies at the cost price of publication.

6. All property accumulated by or with funds derived from Incorporated Societies and placed in the charge of the Institute shall be vested in the Institute, and be used and applied at the discretion of the Board of Governors for public advantage, in like manner with any other of the property of the Institute.

7. Subject to "The New Zealand Institute Act, 1867," and to the foregoing rules, all Societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the bye-laws for their own management, and shall conduct their own affairs.

8. Upon application signed by the Chairman, and countersigned by the Secretary of any Society, accompanied by the certificate required under Rule No. 1, a certificate of incorporation will be granted under the Seal of the Institute, and will remain in force as long as the foregoing rules of the Institute are complied with by the Society.

Section II.

For the Management of the Property of the Institute.

9. All donations by Societies, Public Departments, or private individuals, to the Museum of the Institute, shall be acknowledged by a printed form of receipt, and shall be duly entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

10. Deposits of articles for the Museum may be accepted by the Institute, subject to a fortnight's notice of removal to be given either by the owner of the articles or by the Manager of the Institute, and such deposits shall be duly entered in a separate catalogue.

11. Books relating to Natural Science may be deposited in the Library of the Institute, subject to the following conditions:—

(*a*) Such books are not to be withdrawn by the owner under six months' notice, if such notice shall be required by the Board of Governors.

(*b*) Any funds specially expended on binding and preserving such deposited books, at the request of the depositor, shall be charged against the books, and must be refunded to the Institute before their withdrawal, always subject to special arrangements made with the Board of Governors at the time of deposit.

(*c*) No books deposited in the Library of the Institute shall be removed for temporary use except on the written authority or receipt of the owner, and then only for a period not exceeding seven days at any one time.

12. All books in the Library of the Institute shall be duly entered in a catalogue, which shall be accessible to the public.

13. The public shall be admitted to the use of the Museum and Library, subject to bye-laws to be framed by the Board.

Section III.

14. The Laboratory shall, for the time being, be and remain under the exclusive management of the Manager of the Institute.

Section IV.

Of date 23rd September, 1870.

Honorary Members.

Whereas the rules of the Societies incorporated under the New Zealand Institute Act provide for the election of Honorary Members of such Societies; but inasmuch as such Honorary Members would not thereby become Members of the New Zealand Institute, and whereas it is expedient to make provision for the election of Honorary Members of the New Zealand Institute, it is hereby declared—

1st. Each Incorporated Society may, in the month of November next, nominate for election as Honorary Members of the New Zealand Institute three persons, and in the month of November in each succeeding year one person, not residing in the colony.

2nd. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as Honorary Members is recommended, shall be forthwith forwarded to the Manager of the New Zealand Institute, and shall by him be submitted to the Governors at the next succeeding meeting.

3rd. From the persons so nominated, the Governors may select in the first year not more than nine; and in each succeeding year not more than three, who shall from thenceforth be Honorary Members of the New Zealand Institute, provided that the total number of Honorary Members shall not exceed thirty.

LIST OF INCORPORATED SOCIETIES.

NAME OF SOCIETY.	DATE OF INCORPORATION.
WELLINGTON PHILOSOPHICAL SOCIETY . . .	June 10th, 1868.
AUCKLAND INSTITUTE	June 10th, 1868.
PHILOSOPHICAL INSTITUTE OF CANTERBURY . .	October 22nd, 1868.
OTAGO INSTITUTE	October 18th, 1869.
NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY	Sept. 23rd, 1870.

WELLINGTON PHILOSOPHICAL SOCIETY.

OFFICE-BEARERS FOR 1873.—*President*—Charles Knight, F.R.C.S., F.L.S.; *Vice-Presidents*—J. C. Crawford, F.G.S., Captain F. W. Hutton, F.G.S.; *Council*—W. T. L. Travers, F.L.S., H. F. Logan, James Hector, M.D., F.R.S., John Kebbell, W. S. Hamilton, J. R. George, C. C. Graham; *Hon. Treasurer*—F. M. Ollivier; *Hon. Secretary*—R. B. Gore; *Auditor*—Arthur Baker.

OFFICE-BEARERS FOR 1874.—*President*—Charles Knight, F.R.C.S., F.L.S.; *Vice-Presidents*—J. C. Crawford, F.G.S., W. T. L. Travers, F.L.S.; *Council*—Dr. Hector, F.R.S., H. F. Logan, W. S. Hamilton, J. R. George, C. C. Graham, Commander R. A. Edwin, R.N., J. Blackett, C.E.; *Auditor*—Arthur Baker; *Secretary and Treasurer*—Richard B. Gore.

Extracts from the Rules of the Wellington Philosophical Society.

5. Every Member shall contribute annually to the funds of the Society the sum of one guinea.

6. The annual contribution shall be due on the first day of January in each year.

7. The sum of ten pounds may be paid at any time as a composition for life of the ordinary annual payment.

14. The time and place of the general meetings of Members of the Society shall be fixed by the Council, and duly announced by the Secretary.

AUCKLAND INSTITUTE.

OFFICE-BEARERS FOR 1873.—*President*—His Honour T. B. Gillies; *Council*—J. L. Campbell, M.D., T. Heale, C.E., J. Stewart, C.E., T. Kirk, F.L.S., Rev. J. Kinder, D.D., D. Hay, H. H. Lusk, T. Russell, Hon. Colonel Haultain, Rev. A. G. Purchas, M.R.C.S.E., T. F. S. Tinne; *Auditor*—C. Tothill; *Secretary*—T. Kirk.

OFFICE-BEARERS FOR 1874.—*President*—Chief Justice Sir George A. Arney; *Council*—J. L. Campbell, M.D., J. C. Firth, T. B. Gillies, J. Goodall, C.E., D. Hay, Hon. Col. Haultain, Rev. J. Kinder, D.D., Rev. A. G. Purchas, M.R.C.S.E., J. Stewart, C.E., T. F. S. Tinne, T. Heale; *Auditor*—C. Tothill; *Secretary*—T. F. Cheeseman.

Extracts from the Rules of the Auckland Institute.

4. New Members on election to pay one guinea entrance fee, in addition to the annual subscription of one guinea; the annual subscriptions being payable in advance on the first day of April for the then current year.

5. Members may at any time become Life Members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

10. Annual General Meeting of the Society on the third Monday of February in each year. Ordinary Business Meetings are called by the Council from time to time.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Office-bearers for 1873.—*President*—H. J. Tancred; *Vice-Presidents*—T. H. Potts, F.L.S., Robert Wilkin; *Council*—Julius Haast, Ph.D., F.R.S., G. W. Hall, Ven. Archdeacon Wilson, His Honour Mr. Justice Gresson, Dr. A. C. Barker, W. Montgomery; *Hon. Treasurer*—J. Inglis; *Hon. Secretary*—C. M. Wakefield.

Office-bearers for 1874.—*President*—Julius Haast, Ph.D., F.R.S.; *Vice-Presidents*—Ll. Powell, M.D., G. W. Hall; *Council*—His Honour Mr. Justice Gresson, W. Montgomery, R. W. Fereday, Dr. J. S. Coward, H. J. Tancred, Rev. J. W. Stack; *Hon. Treasurer*—J. Inglis; *Auditors*—J. Palmer, R. Wilkin; *Hon. Secretary*—C. M. Wakefield.

Extracts from the Rules of the Philosophical Institute of Canterbury.

7. The Ordinary Meetings of the Institute shall be held every first week during the months from March to November inclusive.

25. Members of the Institute shall pay two guineas for the first year of membership, and one guinea annually thereafter, as a subscription to the funds of the Institute.

27. Members may compound for all annual subscriptions of the current and future years by paying ten guineas.

OTAGO INSTITUTE.

Office-bearers for 1873.—*President*—His Honour Mr. Justice Chapman; *Vice-Presidents*—Rev. Dr. Stewart, J. T. Thomson, F.R.G.S.; *Council*—Professor Black, M.A., D.Sc., Professor Shand, M.A., Dr. Deck, T. M. Hocken, M.R.C.S.E., R. Gillies, H. Skey, P. Thomson; *Hon. Treasurer*—J. S. Webb; *Hon. Secretary*—D. Brent, M.A.

Office-bearers for 1874.—*President*—J. T. Thomson, F.R.G.S.; *Vice-Presidents*—J. McKerrow, D. Brent; *Council*—Professor Black, W. Blair, C.E., A. Bathgate, R. Gillies, Professor Shand, H. Skey, P. Thomson; *Hon. Treasurer*—J. S. Webb; *Hon. Secretary*—Captain F. W. Hutton, F.G.S.

Extracts from the Rules of the Otago Institute.

3. From and after the 1st September, 1869, any person desiring to join the Society may be elected by ballot, on being proposed in writing at any meeting of the Society by two Members, on payment of the annual subscription for the year then current.

4. Members may at any time become Life Members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

9. An Annual General Meeting of the Members of the Society held on the second Monday of July.

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

OFFICE-BEARERS FOR 1873.—*President*—Sir David Monro; *Vice-President*—The Bishop of Nelson; *Council*—R. Lee, Hon. J. Renwick, J. Shephard, George Williams, M.D., C. Hunter-Brown; *Hon. Treasurer*—J. G. Holloway; *Hon. Secretary*—T. Mackay.

OFFICE-BEARERS FOR 1874.—*President*—Sir David Monro; *Vice-President*—The Bishop of Nelson; *Council*—Leonard Boor, M.R.C.S., Charles Hunter-Brown, Hon. Thomas Renwick, Joseph Shephard, Geo. Williams, M.D.; *Hon. Treasurer*—J. Holloway; *Hon. Secretary*—T. Mackay.

Extracts from the Rules of the Nelson Association for the Promotion of Science and Industry.

2. The Association shall consist of Members elected by ballot, who have been proposed at a Monthly Meeting of the Society, and elected at the ensuing meeting.

3. Each Member to pay a subscription of not less than one pound per annum, payable half-yearly in advance.

4. Ordinary meetings held on the first Wednesday in each month.

TRANSACTIONS.

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE,

1873.

DISCARDED

I.—MISCELLANEOUS.

Art. I.—*On the Variation of the Declination of the Magnetic Needle in the Southern Portion of the Middle Island, and Remarks on the Desirability of Establishing Magnetic Observatories in New Zealand.* By A. H. Ross.

[*Read before the Otago Institute, 24th April,* 1873.]

When a magnetized steel bar is placed on a vertical axis through its centre of gravity, on which it is free to revolve, the axis being between its poles, it will oscillate on each side of a certain determinate position, in which, at length, it will come to rest. When in this position a vertical plane passing through the axis and the poles is called the magnetic meridian. This plane generally forms an angle with the plane of the true meridian of the place in which the magnet is situate. This angle is called the *declination* of the magnet. It is, perhaps, better known to British sailors and others as the variation of the compass. It is to this property of the magnetic needle that I propose to direct attention in this short paper, more particularly, however, to some remarkable variations in declination which occur in different localities in this Province which have come under my notice.

The declination of the magnetic needle is subject to variations of several kinds—secular variation, annual and diurnal variation, accidental variations or perturbations, and local variations.

Observations carefully taken in London and Paris, and extending over a period of nearly three hundred years, show that from about the year 1580 the declination was E. of N. in those places, but decreasing, which it continued to do, until 1657, when the magnetic and terrestrial meridians were coincident, and remained so until 1663. A westerly declination then commenced, and continued increasing, though not regularly, until 1818, when, at London, a

maximum of 24° 41′ was reached. Since then it has gradually diminished: it was 22° 30′ in 1850; in 1866, 20° 25′; and is probably at the present date some few minutes under 20° W.

The annual variation at Paris and London is greatest about the latter end of March in each year, diminishing from that time to the latter end of June, and increasing again during the following nine months. It does not exceed from 15′ to 18′, and it varies somewhat at different epochs.

The diurnal variation differs according to the time of year and place of observation, the mean daily range in London being about 9·3 minutes; in Paris, about 11·5 minutes. The amplitude of the daily variations is greatest from April to September.

The declination is accidentally disturbed in its daily variations by many causes, such as earthquakes, volcanic eruptions, and the aurora borealis and aurora australis. In Ganot's "Elements of Physics" it is said that "the effect of the aurora is felt at great distances. Auroras which are only visible in the north of Europe act on the needle even in these latitudes (that is, of London and Paris), where accidental variations of 20′ have been observed. In polar regions the needle frequently oscillates several degrees; its irregularity on the day before the aurora borealis is a presage of the occurrence of this phenomenon." Although there is little doubt that the declination of the needle is generally affected to a greater or less extent before and during the aurora, yet this is not invariably the case, as the following extract from Captain Parry's narrative of his third voyage for the discovery of a north-west passage will show. The extract is so short and so pertinent to the subject under consideration that I make no apology for introducing it. Speaking of the aurora borealis, he says:—

"About midnight on the 27th of January, 1825, this phenomenon broke out in a single compact mass of brilliant yellow light, situated about a south-east bearing, and appearing only a short distance above the land. This mass of light, notwithstanding its general continuity, sometimes appeared to be evidently composed of numerous pencils of rays, compressed, as it were, laterally into one, its limits, both to the right and left, being well defined and nearly vertical. The light, though very bright at all times, varied almost constantly in intensity, and this had the appearance (not an uncommon one in the aurora) of being produced by one volume of light overlying another, just as we see the darkness and density of smoke increased by cloud rolling over cloud. While Lieutenants Sherer and Ross and myself were admiring the extreme beauty of this phenomenon from the observatory, we all simultaneously uttered an exclamation of surprise at seeing a bright ray of the aurora shoot suddenly downward from the general mass of light, and *between us and the land*, which was then distant only three thousand yards. Had I witnessed

this phenomenon by myself, I should have been disposed to receive with caution the evidence even of my own senses as to this last fact; but the appearance conveying precisely the same idea to three individuals at once, all intently engaged in looking towards the spot, I have no doubt that the ray of light actually passed within that distance of us. About one o'clock on the morning of the 23rd February the aurora again appeared over the hills in a south direction, presenting a brilliant mass of light very similar to that just described. The rolling motion of the light laterally was here also very striking, as well as the increase of its intensity thus occasioned. The light occupied horizontally about a point of the compass, and extended in height scarcely a degree above the land, which seemed, however, to conceal from us a part of the phenomenon. It was always evident enough that the most attenuated light of the aurora sensibly dimmed the stars, like a thin veil drawn over them. We frequently listened for any sound proceeding from this phenomenon, but never heard any."

Now let us see what Captain Parry says in reference to the action of his compasses during the continuance of this phenomenon:—"Our variation needles, which were extremely light, suspended in the most delicate manner, and, from the weak directive energy, susceptible of being acted upon by a very slight disturbing force, were never in a single instance sensibly affected by the aurora, which could scarcely fail to have been observed at some time or other, had any such disturbance taken place, the needles being visited every hour for several months, and oftener when anything occurred to make it desirable."

I believe that the officer in charge of the Dunedin Telegraphic Station has generally observed, on the day preceding a display of aurora, a considerable disturbance in the needles attached to his instruments. Those needles are, however, placed under very different conditions to those to which the needle of a declination compass would be subject; and whilst a current of induced electricity may perhaps (independent of the battery) be directed along the copper wire, which is in close proximity to the telegraph needle, and in accordance with the established law that "electrical force and magnetic force are exerted at right angles to each other," deflect it from its normal position, the isolated declination needle may remain unaffected, or affected only in a slight degree.

In addition to the secular, annual, and accidental variations of the declination, there are also local variations. Within our own Province of Otago there are many such, some of them of a very remarkable character.

The secular variation in the "declination" of the needle, as determined from astronomical observations taken on board ship, in the vicinity of our coast line, is stated on the Admiralty charts to be progressing in an easterly direction at the rate of nearly two minutes per annum.

The first magnetical observation on our shore of which I can find any record was taken by Captain Cook, at Dusky Bay, in May, 1773—one hundred years ago. The declination he found, by the mean of three different needles, to be 13° 49′ East, and the dip, or inclination, 70° 5′ 45″. The next observation in the same place was taken by Captain Stokes, in 1851; the declination was then found to be 15° 34′ E., and the dip, or inclination, 69° 47′. These observations show the secular variation to have progressed at an average annual rate of 1·34 minutes, amounting in the elapsed interval of seventy years to 1° 45′.

I have not alluded to the dip, or inclination, of the magnetic needle, nor did I intend to have done so, but I think it worthy of notice here that the secular variation in the angle of inclination, though of small extent, is in the same direction as at London and Paris, where the dip during the last 150 years has been decreasing at the rate of about 2·6 minutes per annum, and continued to do so during the decrease, as well as during the increase, of the secular variation of the westerly declination.

Proceeding northward to Bluff Harbour, I find, in the "New Zealand Pilot," that the declination there in 1849 was 16° 16′ E. Observations taken in 1866, by Mr. McKerrow, show it to have been at that date 14° 40′ 40″ E., giving a decrease of 1° 35′ 20″. At this place, then, it appears that the secular variation is proceeding in an opposite direction to that indicated on the Admiralty charts, unless we suppose the last observation to have been made at a time of peculiar magnetic disturbance, of which this locality and the neighbouring district between the Bluff and New River are likely to be very susceptible. This may be inferred from the following extracts, the first of which is from the journal of Mr. C. H. Kettle, first Chief Surveyor of this Province, a gentleman whose professional acquirements were of the highest order, whose urbanity and amiability commanded the esteem of all who knew him, and rendered his untimely removal by death a matter of the deepest regret to all who possessed the honour of his friendship or the pleasure of his acquaintance.

Mr. Kettle, who was engaged in laying off the native reserve at the eastern head of the New River estuary, has this entry in his journal:—"Saturday, 10th April, 1852.—Prince and myself went forward to explore until we came in sight of Barracouta Point, from the top of the hills, when we returned to the others, and continued the cutting of the line. Weather cleared up in the afternoon, when we completed the line to the top of the hill. Immense masses of ironstone rock amongst manuka scrub on the descent towards Barracouta Point, which affected the compass so as to turn the north point westward, making the south point dip extremely."

The other extract I shall give is from a report, presented in the early part

of 1857, to the Commissioners of the Waste Land Board, by Mr. J. T. Thomson, Chief Surveyor of Otago, and is as follows:—"In a district like this, situated on one of the great volcanic zones, where terrestrial galvanic currents may be supposed to prevail, it will be correctly surmised that the surface sometimes indicates forcibly the presence of magnetic disturbance. This disturbance was more or less sensibly indicated in our observations, but the most remarkable is on the Bluff Peninsula, as will be seen by the following:—

"On the summit of Bluff - -	variation	6° 54′ E.
"Thirty feet north of the same -	"	9° 36′ W.
"Thirty feet west of the same -	"	5° 04′ E.
"Thirty feet east of the same -	"	46° 44′ E."

To this report is appended the following note:—"The bearing of the magnet is affected in all parts of the Province where hard compact traps crop out. These are found principally on the higher parts of ridges and mountains."

Proceeding northward, we find at Kuriwao Hill the declination to be 13° 53′ 27″ E.; at Toetoes, 14° 19′ 32″; and at Chimney Hill, 14° 56′ 50″. From this to Port Chalmers no remarkable variation in declination has been recorded. I may observe, however, that at all stations on land near the sea-board the declination is less than it is shown to be at sea on the Admiralty charts, the mean difference, after the declination has been corrected for difference of dates of observations, amounting to nearly 2 degrees. At Port Chalmers the declination observed by Mr. Kettle, in 1846, was 16° 10′ E.; by Captain Stokes, in 1850, 15° 40′ E.; in 1864, by Mr. McKerrow, it was 15° 40′ 08″ E., so that in the four years, 1846 to 1850, a decrease of 30′ is shown; while in the fourteen years, 1850 to 1864, no change whatever has been observed, the results given by Mr. McKerrow being virtually the same as those given by Captain Stokes.

North of Port Chalmers the disturbing force at many of the stations is very considerable. In the immediate vicinity of the port at Mihiwaka the declination is shown to be 19° 20′ 48″ E.; at Flagstaff it is 14° 14′ E.; in Nenthorn District, at Mount Stoker, it is 35° 21′ 44″ E. In recording this observation in his field book, Mr. McKerrow made the following entry:—"Hard bluestone boulders on Mount Stoker." At Highlay Hill the declination is 2° 24′ 32″ E.; in Hawksbury District, at Mount Watkins, it is 3° W.; and at Taieri Peak, a few miles to the north, it is 104° 47′ E. In Moeraki District, at Trig. Station O, it is 26° 10′ E.; and at Trig. Station P it is only 50′ E. In Kauroo District, at Mount Difficulty, the declination is 1° 02′ W.; at Trig. Station L, 13° 30′ E.; at Trig. S, 22° E.; at Black Cap, 8° 54′ W. These four stations are included within a radius of about two and a-quarter miles; and, lastly, the declination at Kauroo Hill, about five miles N.E. of Black Cap, is 41° 03′ 35″ E.

I think it unnecessary to notice further observations which have been taken in other parts of the Province. I may state, however, that I have been informed by the officer who triangulated the Moeraki and Hawksbury Districts (Mr. England) that, in many localities other than those noted, aberration of the action of the magnetic needle prevailed to such an extent at the time he was engaged on his survey, that it was in some cases a matter of great difficulty, and in others quite impossible, for him to delineate accurately the topographical features of the country from compass observations. The disturbing force in this District, whatever it may be, exerts its influence beyond the limits of the coast line. Conversing, only yesterday, with the captain of one of our sea-going steamers, I asked him whether he ever perceived anything unusual in the action of his compasses in sailing along the coast. He replied, "Yes; at Moeraki my compasses are always affected," and added that many other masters of vessels had noticed similar irregularities. I was prompted to ask this question by remembering some circumstances in my own experience which, when I relate them, if they do not suggest a probable cause of the effect I have noted, may at least be considered as a somewhat remarkable coincidence. Twenty-five years ago, in the course of business, I held much intercourse with the masters of vessels navigating the north-east coast of England. Frequently, when the action of their compasses was the subject of conversation, I have heard the captains in the coal trade (who, at that time, oftener held their positions in virtue of their having certificates of servitude than of competency, but who, nevertheless, were generally shrewd, observant, and sensible men) remark that in hugging the land when passing a particular place on the Yorkshire coast, which they pointed out on the chart, the compass cards danced about in all directions, and were, so far as indicating the ship's head was concerned, positively useless. Many years subsequent to this—I forget the exact date—those immense deposits of magnetic ore in the Cleveland Hills, the works in connection with which are now giving employment to several thousands of human beings, were discovered, and to their existence, when it became known, the erratic action of the mariner's compass in the locality referred to was attributed—possibly erroneously.

It is not my intention to-night to place before you any of the theories which have been enunciated by the many eminent men who have made this branch of physical science their study, to account for the phenomena connected therewith. I have no hypothesis of my own to offer. I have sometimes been amused—not only amused, but amazed—at the facility with which some persons, enunciators of whimsical theories, by a fanciful manipulation of *data* which ordinary mortals cannot comprehend, have given to the offspring of an excited imagination or an erratic intellect the appearance of an absolutely demonstrated truth. I do not, however, possess this faculty of hypothesizing.

My object is simply to direct attention to a department of science, the existence of which seems in New Zealand to have been wholly forgotten, and to suggest the desirability, nay the necessity, of establishing magnetic observatories in the Colony, where regular and systematic observations may be made of the ever-varying, ever-interesting phenomena. I think that no person will deny the desirability, and that the necessity exists will be apparent when I tell you that, for scientific purposes, the results of the observations I have noted are of comparatively little value; and to say this is not disparaging to the observers, who, I have no hesitation in saying, have taken these observations carefully and accurately. But when we consider that the results obtained by the celebrated Halley, on a voyage made expressly to collect the *data* necessary to determine the elements of magnetic geography, "were deprived of the chief part of the advantages which ought to have attended them, because of the absence of uniformity in his instruments and the neglect of making proper comparisons of them with others," we need not wonder that results obtained by surveyors, when prosecuting their routine duties, are, from similar causes, of little value, and of least value when at the place of observation magnetic disturbance prevails to the greatest extent.

In conclusion, I would suggest, firstly, that a set of magnetical instruments similar to those supplied to the Colonial Observatories at Canada, St. Helena, Cape Colony, Tasmania, Victoria, and India, be furnished to the Observatory at Wellington, and placed under the supervision of Dr. Hector, the Director of the Geological Survey, or some other competent officer; secondly, that a declination compass and dipping needle be supplied to the meteorological observatories in each province*; thirdly, that systematic and regular observations be taken at each station; and, lastly, that at out-stations where any remarkable features present themselves, as at the Bluff, Observation Point, Moeraki and Kauroo Districts, in this Province, periodic observations be made under assimilated conditions. If these suggestions are acted on, I believe that New Zealand will be in a fair way to take a prominent part in removing the veil which yet conceals from mankind what may be termed the moving mysteries of terrestrial magnetism.

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* Some Provinces may possibly be already possessed of some of the required instruments. A very excellent declination compass is, I know, among the stored instruments belonging to our Provincial Government, and which, I think I am correct in saying, has not during a dozen years been taken out of its box, except once, when it was taken out in order to be shown, along with other scientific instruments, at the Exhibition held in Dunedin eight or nine years ago.

Art. II.—*On Observed Irregularities in the Action of the Compass in Iron Steam Vessels.* By A. H. Ross.

[*Read before the Otago Institute, 11th November,* 1873.]

It would be extremely difficult to say how many or how few of the casualties which have occurred on the New Zealand coast to iron-built steamers, which have been engaged in its navigation, may be attributed to compass errors. I have little doubt, however, that a great proportion of them are attributable to that cause, and I have less doubt that, if so, the cause is preventable. How? let us consider. As I intend this paper to be of an entirely practical character, I shall not introduce into it any of the investigations of the subject which have been made by Professor Airy and other eminent men, with a view to discover such general laws of the magnetic disturbance in iron ships as enable us to correct the local attraction. I will simply enumerate a few observations of the action of compasses on board two of our coasting steamers, taken by myself during the present year, and offer a few remarks with a view to the removal of what I consider to be a source of great danger to life and property, viz., the navigating of our iron-built screw steamers by means of tabulated cards of deviations.

On the deck of one of the vessels on board of which I took notes, two binnacles were placed, in each of which was suspended an apparently well-made compass; one was placed immediately in front of the wheel, the other about thirty feet forward. Upon no course steered during the voyage did the compasses indicate alike; there were continual, though not constant, differences, varying with every change in the direction of the ship's head. The least difference which I observed amounted to about 12 degrees—a little over one point: this occurred when the vessel's head was N.N.E.; the greatest, about 27°, or nearly 2½ points, when the direction steered was W.N.W. These notes were taken when making the northward voyage. The southward voyage I made in another vessel; the compasses on board were placed somewhat similarly to those in the first ship, the distance between them being, however, not quite so great. The difference between the indications of the compasses were much greater than in the former case. I noted them carefully, as follows:—

1st. Stern compass, W. ¾ S.
Forward compass, S.S.W. ¼ S. } Difference, 78° 45′, or 7 points.

2nd. Stern compass, W.
Forward compass, S.S.W. } Difference, 67° 30′, or 6 points.

3rd. Stern compass, W.N.W.
Forward compass, S.W. ½ W. } Difference, 61° 52½′, or 5½ points.

4th. Stern compass, W. by N. $\frac{1}{4}$ N. / Forward compass, S.W. by S. $\frac{1}{2}$ S. } Difference, 73° 07$\frac{1}{2}$′, or 6$\frac{1}{2}$ points.

5th. Stern compass, W.N.W. / Forward compass, S.W. by S. } Difference, 78° 45′, or 7 points.

The last-mentioned difference was noted during a dense fog, and differs 1$\frac{1}{2}$ points from No. 3, taken when the stern compass indicated the same course, viz., W.N.W. The observations were taken when the ship was on an even keel. The use of a card of deviations in this case is dangerous in the extreme, as the officer on watch not only has to apply the correction to the forward, or standard compass, but, in giving the course to the man at the wheel, has to apply a second correction, both corrections being different on each course: on some courses +, on others —. The liability to err in applying these corrections is therefore great. It is not to be wondered at if the captain, after having, at a late hour of the evening, given a course in order to clear a certain headland, should at daybreak find his ship three or four miles nearer the land than he reckoned upon; or that, having at night given a course which he expected would keep his vessel running parallel to the land, he should in the morning find himself out of sight of land altogether. After considerable experience in the adjustment of the compasses of iron vessels, I have no hesitation in saying that I believe that the local attraction in vessels navigating in these latitudes can be easily and effectually neutralized, and that, by this being done, the safety of passengers and property would be secured, and the officers in charge relieved from a mental strain to which they ought not to be subjected. Let us see what are the inferences drawn by Professor Airy from the elaborate investigations made by that eminent philosopher on this subject. He says:—

1st. At any place the deviation of the compass in any ship, whether wood-built or iron-built, may be accurately represented as the effect of the combination of two forces, one of which alone would produce a disturbance, following the law of polar-magnet-deviation; and the other alone would produce a disturbance, following the law of quadrantal deviation. In northern magnetic latitudes, the nature of the effect of the first will usually be the same as if the boreal magnetism were towards the ship's head; in southern magnetic latitudes, it will be usually the same as if the austral magnetism were towards the ship's head—the quadrantal deviation will be the same in all magnetic latitudes—and whatever the magnitude of the earth's directive force. These are the disturbances that are produced by transient induced magnetism only. The polar magnet deviation will, however, be affected in a greater or less degree if the iron which enters into the composition of a ship possess independent polar magnetism, similar to that of a magnetized steel bar, *i.e.*, not depending on the terrestrial magnetism at the

present moment for its existence; and not changing its amount, or quality, or direction in regard to the ship's keel, while the ship is swung round in different positions. From the slowness of its changes, this has been designated by Professor Airy, "sub-permanent magnetism."

I will now proceed experimentally to show the difference between what is termed transient induced magnetism and the sub-permanent magnetism above mentioned. I take this piece of bar iron, and place it in the line of the magnetic meridian; parallel to the bar, near its north end, I place this small compass; the north end of the compass needle is repelled. I now place the compass similarly near the south end of the bar; the south end of the compass needle is now repelled. Reverse the bar end for end; the result is the same—the end which formerly, when pointing north, repelled the north end of the compass needle, now attracts it and repels the south end, showing that, although the bar has reversed its position, the magnetic current maintains the same direction. This may be termed "horizontal induced magnetism."

I now hold the bar in the line of the magnetic dip, or nearly vertical; the upper end attracts the south end of the compass needle, the lower end of the bar attracts the north end of the compass needle. Reverse the bar by turning its lower end up, and the results are the same, shewing, as before, that the magnetic current maintains the same direction. This is termed "vertical induced magnetism."

In the northern hemisphere the *upper* end of the bar would attract the north end of the compass needle, and the lower the south end—just contrary to the results obtained in this hemisphere. From this cause the north end of a ship's compass needle is drawn to windward when a ship heels over in the northern hemisphere, and the south end is drawn to windward in the southern hemisphere under similar circumstances. When sailing due east or west it is evident that no deviation will be caused by the vertical induced magnetism of the vessel.

I now take this small bar of steel, which has (probably in the process of rolling) acquired a certain amount of magnetism. If I hold the compass to the one end of the bar, the north end of the needle is attracted, no matter in what position the bar may be placed. This represents what is termed the sub-permanent magnetism of the ship. At any place the deviation of the compass may be accurately corrected by mechanical methods; namely, by a magnet in the athwart ship direction, fixed, at a distance determined by trial, for correcting the deviation when the ship's head is north or south; by a magnet in the head and stern direction, also at a distance determined by trial, for correcting the deviation when the ship's head is east or west; and by a mass of unmagnetized iron (a small box of chain is best) at the same level as the compass in the athwart-ship line, or in the head and stern line, according to circumstances,

(usually in the former), also at a distance determined by trial, for correcting the deviation when the ship's head is N.E., S.E., S.W., or N.W. For the same ship the mass of unmagnetized iron, if adjusted at one port, will produce its due effect in all parts of the world, without ever requiring change or adjustment. The quadrantal deviation may thus be accurately corrected, leaving only the polar-magnet deviation uncorrected. The elements of polar-magnet deviation are liable to changes, but of very different amounts in different ships.

"It is therefore," says Professor Airy, "imperatively the duty of every captain of a ship, particularly of an iron-built ship, to examine the state of the compasses at every opportunity. For the correctness of the compasses may be vitiated, not only by changes in the polar-magnetism of the ship, but also by changes in the intensity of the magnets used for the correction. But as the quadrantal deviation is not liable to any doubt whatever, it is sufficient, for ascertaining the existence and recording the amount of error of the polar-magnet deviation, to observe the error when the ship's head is N. or S., and when it is E. or W."

From whatever cause the changes in the elements of polar-magnet-deviation may arise (whether from a real change in the sub-permanent magnetism of the ship, or from the variation of that part of induced magnetism which is similar to polar magnetism, but which changes in different magnetic latitudes) they may be precisely corrected by re-adjusting the position of the magnets, leaving the unmagnetized iron undisturbed. And the change (if there is any) in the intensity of the correcting magnets will also be corrected, as to its effect on the compass, by the same re-adjustment of position. The re-adjustment can always be effected in harbour in a very short time. Or it may probably be done at sea by reference to a compass carried high up the ship's mast. It can also be done with the aid of astronomical observations, and of a knowledge of the local "variation" or "declination." In all cases the mere adjustment of the magnets is an extremely rapid process.

Professor Airy denounces as dangerous any system of navigating a ship by forming a table of compass deviations at the starting port, and using that table until means of correction can be obtained from observations; and expresses an opinion that it ought at once to be discontinued. It does not, in the smallest degree, provide against the effects of possible change in the ship's sub-permanent magnetism during the interval in which no observations are obtained (which, with sometimes a minute change in the power of the magnets, is the only risk to which the method of mechanical correction is liable), and as it does not recognise the effect of the variation in the magnitude of terrestrial-horizontal magnetism at different places (which alters the compass

deviation by changing the proportion of the ship's sub-permanent magnetism to the terrestrial-horizontal magnetism, upon which proportion the compass deviation depends), it gratuitously introduces a class of errors which are entirely avoided by correcting the compasses by magnets and soft iron.

The changes which occur in the magnetism of a ship sailing from one hemisphere to another, say from the Clyde to Port Chalmers (the difference of magnetic latitude being somewhere about 100 degrees), cannot take place in vessels traversing ten or twenty degrees in one hemisphere only; in fact, I believe that if one of our intercolonial steamers had the compasses on board accurately adjusted in a New Zealand port, by means of magnets and soft iron, the deviation from such changes as those to which I have alluded would be almost, if not altogether, imperceptible in a voyage to or from Melbourne.

I have perused with great pleasure the paper by Captain Edwin in the last volume of the "Transactions" (Trans. N.Z. Inst., Vol. V., p. 128), and, although I agree to a very great extent with his remarks, I am inclined to think that the smallness of the magnetic disturbance in the "Luna" is not so much owing to that vessel having been built of steel, as to the fact of her having wooden bulwarks and the very careful manner in which the position of her compass has been selected; and I think it probable that the difference in deviation observed on board that vessel between Auckland and the Bluff might be altogether eliminated by means of soft iron alone.

Art. III.—*Description of the Patent Slip at Evans Bay, Wellington, and of the Mode of Erecting or Constructing the same.* By J. Rees George, C.E.

(Pl. IV.)

[*Read before the Wellington Philosophical Society, 13th October,* 1873.]

The slip consists of a set of ways, upon which is placed a carriage or cradle running on wheels. The carriage is constructed suitably for hauling up or lowering away ships, motion being given to it by means of a winch or set of geared wheels, hauling-up and lowering-down chains being attached thereto; and the whole is set in motion by means of two 25 horse-power horizontal high-pressure steam engines, placed in position for the purpose.

The ways or rails are manufactured of cast iron. The centre way (which bears the greater portion of the weight of a vessel when being raised) is of the section of two ordinary E girders, connected together at their top tables and other points, two rails 2 ft. 6 in. apart from centre to centre being cast on the top, and two racks to take the palls as a vessel is being hauled up to

prevent the carriage running back. The outer ways are of the section of an ordinary I girder, with a rail cast on the top. The distance apart from centre to centre of outer ways is 30 ft., the ways being kept to their proper gauge by means of cast iron stays placed at intervals of 18 ft., and bolted to the ways. The ways are cast in lengths of 9 ft., the faces of meeting, or ends, being faced or planed so that a correct joint and continuous bearing surface is produced, each length being bolted to the other by bolts passing through the end flanges. Above high-water mark the ways are bolted to sleepers of hinau or totara 12 in. × 10 in., the sleepers being 3 ft. apart from centre to centre, the centre sleepers being 6 ft. in length, and the outer ones 3 ft. The greater portion of the surface consists of rock, which was excavated to the required depth to admit the sleepers and ways, which, after being accurately levelled and graded, were grouted in with Portland cement, and the ground levelled up to the bottom of the rail with rubble. In one or two places the ground was too soft to carry the ways with safety in this manner, and in these cases piles were driven to depths varying from 5 ft. to 15 ft., to which the sleepers were secured. Below high-water mark the ways or rails are bolted to cross sleepers of totara, 33 ft. in length and 12 in. × 10 in., at intervals of 3 ft. centres; four piles being driven under each sleeper, until a depth of 14 ft. of water at high tide was reached. This depth being sufficient to allow 8 ft. of water over the carriage, it was not considered necessary to extend the piles beyond this depth, as a large vessel would weigh very little on the carriage when drawing this amount of water. Beyond this depth, four longitudinal timbers were laid under the sleepers, two being under the centre rail, and one under each of the outer rails. Where the contour of the bottom of the bay differed from the inclination or gradient of the ways, cast iron stanchions or columns are introduced between the sleepers and the ways. The whole of the timber is covered with concrete to protect it from the ravages of the worm.

It was contemplated when the slip was designed, that the site on which it was to be fixed would be sufficiently solid to carry the ways or columns without the intervention of sleepers. The cost of the material would have been considerably reduced had the exact nature of the bottom been known when the design was prepared. The actual weight per foot run of ways and stays, or distance pieces, is about 7 cwt., and to this has to be added the weight of the columns or stanchions, as well as the bolts and other fastenings.

The total length of the ways laid down is 1,050 ft. The gradient, or inclination, is 1 in 23. At the end of the ways, a stop is fixed in the centre line to prevent the carriage from over-running the rails when a vessel is launched. The carriage or cradle is 250 ft. in length on the centre beams, and is made in two pieces; the principal length, which is 180 ft. long, being sufficient to accommodate the class of vessels now frequenting the port of

Wellington. The second length, of 70 ft., is shunted off the ways, but can be attached in an hour or two when it is required to raise a long vessel. The object gained in disconnecting the two pieces, is the saving of wear and tear and waste of power in hauling up and lowering this extra length of cradle, which is not required for any vessel not exceeding 200 ft. in length. The weight of the cradle is about 200 tons, and that of the part detached about 60 tons. The centre longitudinal beam consists of a double line of 18 in. × 12 in. iron-bark timber, made into continuous length by scarfing each length of timber together, the scarf being secured by wooden keys and a scarf plate on each side $\frac{3}{4}$ in. thick ; distance pieces are fixed at intervals of 4 ft. to keep the two beams at their proper distance from each other. The outer beams are of 18 in. × 11 in. iron-bark, secured in the same manner at the scarfs as the centre beams, while the width between the centres of the outer beams is 30 ft., corresponding with the width of the ways.

The wheels are of solid cast iron, each wheel having a $2\frac{1}{4}$ in. wrought iron shaft cast in, and are 1 ft. in diameter ; the wheel carriages, also of cast iron, being secured to the longitudinal beams with four $1\frac{1}{8}$ in. bolts. There are sixteen pall carriages fixed in convenient positions on the centre beams, to allow the palls to fall into the rack cast on the centre ways ; cranked bars and triggers are fixed to allow the palls to be freed under water, after a vessel is placed on the carriage. The power to raise a vessel is applied to the fore part of the centre beams, a pulley wheel 4 ft. in diameter being fixed suitably for the chain to pass over ; the wheel works loose on a shaft of 5 in. diameter. A cross beam, made of two pieces of iron-bark 16 in. × 8 in., is fixed across the lower end of each length of the carriage ; two strong diagonal struts are also fixed from the centre to outer beams. These beams and struts serve to keep the outer longitudinals in their position when a vessel is being raised, the fore part of the outer beams being kept to gauge by iron rods crooked at each end and dropping into a socket. On the longitudinal beams are placed the bilge beams, or slide beams, formed of a suitable shape to take the bilge of a vessel, being of a depth of 1 ft. over the centre beam and 2 ft. over the outer beam ; they are secured to the outer beams by means of iron brackets and cotters, and to the centre beam by means of an iron catch fitting into one side of the slide beam, in the shape of a mortise and tenon in wood work. A space of 8 in. or 10 in. is left between the beams, which is filled with wedges fixing the slide beams firmly in the catches. The slide beams are 15 ft. apart from the centre, there being twelve slide beams on each side of the carriage. At the end of four slide beams on each side there are sockets in which standards are placed for keeping the ends of the ropes used for working the sliding blocks and palls above water. The sliding blocks work on the top of the slide beams, and on to these blocks pieces of wood are secured with dogs to suit the bilges

To accompany Paper on Wellington Patent Slip.

of the vessel to be raised. Small blocks or pulleys are fixed in positions to guide the ropes in the proper directions, both for the sliding blocks and the palls.

The steam engines for working the slip consist of two 25 horse-power horizontal high-pressure engines, manufactured by Messrs Appleby Brothers, of London. Steam is supplied to the engines by two single-flued circular boilers, 30 ft. in length and 5 ft. in diameter. They are erected in a building about 50 ft. distant from the engine house. The reason for placing them so far distant was to avoid the expense of a heavy cutting that would have been required to place them close to the engines. It is not found that any loss is sustained beyond the expenditure of steam necessary to warm the steam-pipe in the first instance, the steam-pipe being, of course, covered in with hair-felt. The boilers are supplied with water by means of a Giffard's patent injector, but can also be supplied by the pumps attached to the engines; the usual pressure gauges, safety-valves, blow-off cocks, etc., being also fixed. The boilers were constructed at Messrs. Kennard Brothers' works at Crumlin, being sent out to the colony in sheets, and rivetted together on the work. They were tested, by hydraulic pressure, to upwards of 100 lbs. to the square inch before being set into their places in brickwork; the usual pressure at which they are worked when a vessel is being raised is 45 lbs. to 50 lbs. to the square inch.

The engines are attached to a train of wheels, or winch, which, when working in slow purchase, multiply the power of the engines seventeen times, while a quicker purchase multiplies the power of the engines nine times. There are seven cog-wheels in the winch, the last and largest being fixed on a shaft of 14 in. diameter, on which the chain wheels work; the wheel for the large chain being 7 ft. in diameter, and for the small chain 9 ft. These wheels are loose on the shaft, and are put in gear by means of a clutch worked with a screw and hand-wheel. The chain wheels are grooved to take the chain, having suitable teeth cast in the groove for each alternate link of the chain to bear upon. The hauling-up chain is 1,700 ft. in length, and made of iron 3 in. in diameter, each stud link being 18 in. in length. For small vessels of 500 tons or under, this chain is worked single, being shackled round the pulley wheel at the head of the cradle; but when it is required to raise a large vessel the chain is worked double, the return end being secured to an anchor block fixed in a suitable position near the winding engine. The small chain, or lowering-out chain, is of 1¼ in. iron, one-half being made in long links to suit the teeth of the wheel, and the remainder in lengths of ordinary short-link chain shackled together. This chain is secured in the form of an endless chain, both ends being shackled to the head of the carriage. A pulley wheel is fixed at about 165 ft. from the outer end of the ways, round which the

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clearing away the ground under the sleepers. The mode of raising the earth was by means of a shallow iron box, which was pushed out under the bottom edge of the bell as soon as filled, the box being lifted on to the punts, and the material thrown into a boat and removed. A rope was attached inside the bell to enable the box to be pulled in to the bell again when emptied and lowered to the bottom; and a trigger, or piston, passed through the top of the bell, afforded means of signalling when it was necessary to raise or lower the bell with the rise and fall of the tide.

So soon as a length of 18 ft. of ground had been cleared and levelled by means of the bell, piles were driven in their proper positions under the sleepers; they were cut off to the length required, and driven down their full depth, in order to save the expense of cutting off the piles under water. To drive them, a dummy pile, of the requisite length of the same section as the pile to be driven, was used; strong angle irons were placed on each corner, projecting about 3 ft. beyond the lower end, and were secured with iron straps and bolts. The angle irons being loosened, the head of the pile to be driven was inserted between them, the irons, or guides, being screwed up tight, thus securing the head of the pile in its proper position. The pile was then dropped into its place, and driven down to the required depth. When driving piles, two pile-engines were kept in use; the pile being fixed into the dummy one, while the other was being driven down. When down to the required depth, the dummy was lifted off with the steam-crab, which was then available to proceed with the pile on the second engine. As the water deepened it was found necessary to provide some means to guide the point of the pile into its proper place, and this was effected by means of L iron frames placed on the small carriage used for lowering out the ways. These frames were made to run on wheels bolted to the sides of longitudinal beams, cross pieces being fixed 3 ft. apart on the frames, through which a bolt was dropped into a hole in the beam to keep it to its proper gauge. When it was required to drive piles, this carriage, with the frames on, was lowered out to the end of the ways already laid, the diver being stationed below at the same place; a pile being ready to drive was then lowered down to the diver, who, having placed the iron frame to the required distance, guided the pile in between rollers provided for the purpose at the end of the frame, and then dropped it slowly on to the ground; on one blow being given to it, the rollers were removed and the iron frame pushed back clear of the pile, the diver then proceeding to place the next pile in position.

On the completion of a length of piles sufficient for 18 ft. in length of ways, the carriage was pulled up out of the water, and a section of the ways and sleepers built together on it ready for lowering into its place, the sling chains being fixed in place and buoyed with a small rope and buoy to enable them to

it is out into water deep enough to allow a vessel to pass over it. The stem or nose of the vessel is hauled up into the guide on the head of the cradle, which is simply a pair of iron bars bent to the proper shape and bolted on to the cradle. The stern of the vessel being hauled into its proper place, the keel is over the centre of the carriage ; the back guides are then lifted up to secure the vessel in its place. The back guides are strong iron bars, working separately on a 4 in. pin, passing through strong uprights bolted to the side of the longitudinal beams at such distances as may be required to suit the length of a vessel. So soon as a vessel is thus fixed in position, the cradle is hauled up until the keel rests its whole length on the cradle, and the bilge blocks being then pulled under the vessel's bottom she is hauled up out of the water, the palls being dropped so soon as the bilge blocks are pulled into their proper position. These palls prevent a vessel running back into the water in the event of its being necessary, from any cause, to take the weight off the machinery, and also serve to keep the cradle in its place when up on the ways.

To launch a vessel, the cradle is hauled up sufficiently to allow the palls to be lifted. It is then lowered, by means of the large chain, conveniently near to the water's edge ; the large chain is then released, and the cradle and vessel allowed to run out by their own impetus, taking, of course, the small chain. The mode of releasing the large chain is by knocking the pin out of the shackle which secures the return end when passed round the wheel at the head of the carriage, the pin being made conical for the purpose. The impetus caused by running out generally carries the vessel clear of the cradle, but if, from any cause, the vessel does not run out sufficiently fast to clear the cradle, the small chain serves to haul it into deeper water to clear it, and, the engine being reversed, the small chain hauls up the cradle out of the water.

It is sometimes required to raise a second vessel when the cradle is occupied. This is effected by blocking the vessel already up off the cradle. To do this wooden blocks are placed under the vessel between all the bilge beams of the cradle, and the weight of the vessel taken off the cradle by wedging these blocks up tightly. To allow the cradle to be removed, and to clear the keel of any vessel requiring it, small pieces of wood, 2 in. thick, are nailed on to the keel blocks on the centre longitudinal beam before a vessel is taken up. When a vessel is tightly wedged up on to the wooden blocks, as described, these small pieces are split out, leaving a space between the keel of the vessel and the cradle. The bilge beams are removed by knocking out the wedges and releasing the ends from the teeth on the centre beam, and taking out the cotter pins on the outer longitudinals. The bottom of the vessel being thus cleared of the cradle, it is hauled out from under by means of the small chain ; the bilge beams, etc., are then replaced in position, and the cradle lowered into the water in the usual way, the chains working under the

be picked up when the carriage reached the end of the ways already laid. Before a length of ways was lowered, the next section was fitted to it and bolts tried through the holes, so that the diver had no fitting work to do under water. On the section of ways being picked up, the traveller was run out a sufficient distance and the section of ways, sleepers, etc., dropped as nearly into its position as possible; the diver then unfastened the rope with which the carriage was worked, and attached it to a long hook made to pass through the flange of the section being placed, and the section already fixed on the rope being hauled in by the crab which worked the carriage, the two flanges were drawn up close together. The diver then secured the flanges together by means of a vice at each flange. The section of 18 ft. in length (the total weight of iron and timber in the same being some eight or ten tons) being thus approximately in its position, the next operation consisted in levelling it to the gradient of the ways and checking its position on the centre line. To enable the end of the section to be lifted after being released by the traveller, four iron brackets were bolted temporarily on the outer flange before sending down the carriage; under these brackets the diver placed four screws, like wool screws; the carriage was then lowered out over the section of the ways to be levelled. Iron bars, cut to the proper length to reach above the water, were then dropped through tubes in the beams of the carriage on to the rails to be levelled, and on the end of the last piece fixed. When the water was deep it became necessary to stay these bars together at the top, as the least current or motion set the bars swaying out of the perpendicular, but when four or six bars were braced together there was no tendency to sway. The bars being in place, the centre rail was first levelled to the gradient by means of a spirit level placed on the top of the bars, the diver below raising or lowering the end of the ways, by means of the screw placed under the brackets, as was required. The side rails were levelled to the centre rail by the same means. To further check the gradient, bars of equal length were placed on the end of ways, to be levelled at high-water mark and at the top of the ways near the engine-house, the tops of the bars being proved to be all in line by means of a glass. It was found necessary to adopt this mode of levelling when the weather was too rough to level off a boat. To correct the centre line, a fine copper wire was placed on the exact centre at high water-mark, and a frame with a like copper wire and heavy plumbob was placed over the end of the ways to be corrected. A centre mark had been placed on the end of the iron work before lowering out, and the diver below, observing when the plumbob was in position over this centre mark, signalled to the men above to shift the wire as required. The two wires were then seen by a glass to be in line with the centre mark on the opposite side of the bay, a distance of about three-quarters of a mile. On one occasion only did it become necessary to shift the end of the ways, and then only about 1 in.

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vessel on the ways. To replace a vessel on the cradle, the operation is merely the reverse of that just described.

The time occupied in raising a vessel after it is once fixed securely on the carriage is, in the case of small vessels, about twenty minutes, when the hauling-up chain is worked single. With a large vessel the speed is found to be about 15 ft. or 16 ft. per minute. In this case the chain is used double.

Dolphins, consisting of clusters of five piles, are placed in convenient positions for steadying a vessel going on the slip. At present only three of the dolphins are completed, but three more are to be erected. The piles used for these dolphins are of the jarrah wood of South Australia, which is believed to resist the worm for an unlimited period.

ART. IV.—*On a Smokeless and Self-feeding Furnace for Lignites and other Fuels, and the Utilization of the Waste Heat.* By H. SKEY.

(Pl. V.)

[*Read before the Otago Institute, 12th August,* 1873.]

AT a time when the material wealth of nations is recognised as being so intimately associated with those immense stores of power obtainable from the fuels occurring in the carboniferous deposits of past ages, any apology for treating on the economic consumption of these fuels would be superfluous.

It is evident that when fuel, of whatever kind, is consumed in such a manner that there is no smoke evolved, and no cinders and unoxidized portions of the fuel left among the ash, then the theoretical conditions leading to the evolution of all the heat force are present, so far as the furnace itself is concerned; while it belongs to the external arrangements, such as form of boiler and flues, and perfection of engine employed, to determine how much of this force is actually available, or, in other words, how much *duty* can be obtained from a given weight of fuel.

Judging of the evaporating power of fuels by the amount of their fixed carbon, their analyses show that the combustion of 1·5 tons of Green Island or Clutha coal should produce the same amount of steam as one ton of Newcastle coal. If we take one ton of Newcastle coal and consume it in a given time —say twenty-four hours—in an ordinary furnace specially adapted for the combustion of this and other coals that coke and can be stirred, and then, in the *same* furnace, attempt the combustion of the equivalent 1·5 tons of Green Island coal in the same time, failure would be the probable result. For, in the first place, the bottom of the fire and fire-bars would soon be covered with an

accumulation of ash and small fuel, which would prevent a proper supply of oxygen to the rest of the fuel and to the evolved gases—the fire, therefore, smoulders rather than burns; and, secondly, when the fire is stirred (and also when fresh fuel is added) a certain amount of the burning fuel is broken and falls through the bars to waste, and if the fire-bars are placed nearer to each other, with a view to prevent the fuel passing through them, so much more will the draught be impeded. Another evil arising from the stoppage of air through the fire will be that unburnt gases and smoke pass up the chimney. Now, if these sources of waste were removed, there would, of course, be the same quantity of heat evolved from the $1\frac{1}{2}$ tons of Green Island coal as from the ton of Newcastle coal; but considerably more time would be required, first in getting up the fire, and then in consuming it, which is a serious drawback to its use for steam purposes, and determines the use of Newcastle and other coals even in those places where the brown coals may be said to be at our very doors.

It becomes a matter of importance, therefore, to consider whether a special construction of furnace could be devised in which the ashes are removed as soon as formed from all parts of the glowing fire, and all the evolved gases which are capable of uniting with the oxygen of the air thoroughly oxidized, while, at the same time, such a degree of intensity may be imparted to the combustion as to render it available for the generation of steam with the rapidity requisite for marine boilers and locomotives.

To effect this, I propose to do away with the fire-bars, and to use a certain fraction of the heat force of the furnace (when changed into its equivalent motive force), so that it shall send a gentle blast of air upwards through all parts of the fuel, and thence through a great number of small and thin copper tubes of the boiler till it reaches the smoke box. It now becomes necessary, before proceeding further, to consider the relative specific gravities of the contents of the furnace after the fire has been kindled some time and the blast in operation; and there is this remarkable property which must have struck everyone that has used these brown coals, with regard to their ashes, namely, their extreme lightness and the ease with which they are reduced to an impalpable powder.

Specific gravity of Clutha coal - - - -	1·26
Specific gravity of its ash flake - - - -	0·04

The ash is therefore about thirty times lighter than the fuel, and twenty times lighter even when the volatile gases are driven off from it. It is important that these bulky ashes be removed, not only from the bottom of the furnace, but from every part of the glowing fuel, for dust would not be more obstructive to the proper action of the human lungs than accumulations of ash to that of a furnace. The difference between the specific gravities of coal and its ash flake allows, therefore, of its removal as fast as it is formed, while the

clean and glowing fuel remains, and is by the same means supplied with a constant stream of oxygen; heat of any required intensity is thus produced, which can be adjusted by regulating the blast. If we take the experimental quantity of 1·5 tons of lignite, and consume it in twenty-four hours, then the furnace must be supplied with a charge of 14lbs. of fuel every six minutes, and as this fuel yields on analysis 5·5 per cent. of ash, it follows that only ¾lb. of ash requires removing and carrying along with the draught in the six minutes.

We may now consider whether there is really any loss of power, and, if so, how much, by the use of a blast. By its use, the tall chimney is, of course, dispensed with. It may be thought that the draught caused by ordinary chimneys costs nothing; but is it not a fact that a certain amount of motive force, or its equivalent of heat force, is used in the act of causing a draught in common chimneys, and that if all the heat of the furnace were really utilized (as by evaporating the theoretical amount of water, for instance), there could then be no heat left to expand the column of air in the chimney to work the draught, for the gases evolved would be no hotter than the ordinary temperature of the atmosphere? The modern theory of heat shows that in whatever manner work is done, if work be done at all, then its equivalent of heat force is expended. Now, the column of ascending gases and air in a chimney is continually pushing away the atmosphere and making room for its passage through it. The furnace may be taken as so much colder by that amount, that is, there will be that amount of heat less that can be used for evaporating the water.

Experiment No. 1.—In a closed furnace, specially arranged so that no air could pass into it except through the burning fuel, a thermometer was attached so that the bulb projected into the furnace about 3 in. above the fuel, until it showed a constant temperature of 286°, with the damper open; then, on shutting the damper in the chimney, in seven minutes it rose to 358°; then opened it a very little, the temperature at once fell proportionately to the amount that the damper was opened; on opening it wider, it fell to 285°; then completely closed it, when it rose in three minutes to 320°. This experiment was varied with like results. Also, on another occasion, when the thermometer was removed and a vessel of water placed on the top, it commenced boiling when the damper was shut, and immediately ceased when it was opened. This was repeated several times, which results may be ascribed principally to the fact of the gases above the fire being more easily heated under the extra pressure when the damper is shut; for when it is opened, then some of the heat can exert itself in expanding the gases in the chimney, and thus disappears. Now let the chimney be removed and the fire supplied with the same amount of air from a blast, and there can be no more

dynamic force required to work the blast than could be obtained from the heat which disappears in a chimney. It has been calculated that 1lb. of coals employed to raise steam will do the work of 500lbs. expended in rarefying air, such air being discharged through a chimney 35 ft. high.

After proving that there is no real loss of power by the using of the blast, we will proceed to consider how it now opens up a way to utilize a large portion of the waste heat after it leaves either the tubes of the steam boiler or the super-heater and hot-air jackets of the engine. It has been calculated that 1lb. of coal should vaporize 14lbs. of water from 212° F., whereas about 10lbs. only are evaporated in Cornish boilers; this is ascribed mainly to the large amount of heat which passes up the chimney. Taking the temperature of the contents of the boiler to be 300° F., that of the gases leaving the tubes is considerably more than this, being in locomotives as high as 600° F., or about one-fourth of the total heat of the furnace. Now, in common boilers, if we cool this heated air in the chimney by attempting to utilize this heat, we at once impair the draught, but the use of the blast allows us to exhaust all the heat we can the moment that it leaves the boiler. The way that I propose to utilize this heat, is to cause it to raise the temperature of all the large volume of air which is required for the combustion of the fuel in the furnace. The apparatus—which we may call, for convenience, a thermo-convector—corresponds to the ordinary smoke-box somewhat enlarged, and divided horizontally into a series of narrow compartments, the connections of which alternate as in the figure (Plate V.), so that the discharged products of combustion pass along those spaces marked BB in the direction of the arrows, while the current of fresh air is conveyed in the opposite direction within the other spaces AA. These latter spaces also communicate with one another by broad lateral arches not shown in the figure. We have, now, virtually two broad and narrow tubes. The walls or partitions of these tubes should be of material specially selected, either for its transmitting power, or else for its conducting power, such as a metal with its surfaces so prepared as to facilitate the absorption and radiation of heat, as, for instance, thin unpolished sheet-iron, which is usually covered with oxide of iron, which oxide Tyndall has shown to be almost as effective an absorber and radiator for obscure heat as lampblack, which is, as we know, capable of absorbing nearly all the heat from any source, luminous or obscure.

Experiment No. 2.—A common thermometer at 60° was placed 1 in. distant from a heated mass of iron, forming a constant source of obscure radiant heat; in seven minutes it rose to 118°. A large piece of the oxidized iron was then interposed midway between, and the thermometer (previously cooled to 60°) was returned, when in seven minutes it rose to 104°. The thermometer was then removed to a place where the temperature was 60°;

then, in four minutes, it sank to 64°, and in six minutes to 63°. This indicates a loss of heat corresponding to only 14° F. by the interposition of the sheet of oxidized iron. This material was proved to heat very rapidly, and it also cools rapidly if a current of cooler air is passed over it.

From these considerations it is evident that the heat in the flattened tubes BB is continually radiating as long as there is a current of cooler air flowing through the other tube AA. Let us assume that the gases in both tubes are similar in quantity and properties, then it follows that all the air required by the furnace can be formed into a hot blast, having a temperature of at least 300° F. This is on the assumption that the fresh air is made no hotter than it would be if actually mixed with all the evolved gases; but it will be seen that, by a proper arrangement and selection of material for the tubes, the air will have been raised to nearly 300° when it has traversed only half the length of the tube, or at A^2; consequently, as it goes onward to a still hotter part, near the tube B, it is continually acquiring fresh accessions of heat until it reaches that part of the thermo-convector where the temperature is, as we have seen, 600°; and similarly it may be shown that the evolved gases are cooled down to near 300° when they reach B^2, and as they pass on they are rapidly cooled by imparting heat to the incoming current of cooler air. In the above apparatus, conduction and surface radiation only are alluded to; but let us consider if transmission through a diathermanous medium could not be employed to advantage. We are indebted to Melloni for the discovery of the almost perfect transparency of rock-salt for all kinds of radiant heat. It, moreover, does not appear to suffer by a heat approaching to redness. I am unable to ascertain if there is any difficulty in procuring it in large pieces, but as optical perfection would not be necessary, and plenty can doubtless be procured sufficiently transparent, small panes of this substance could be inserted at the top of each convolution of the air tube A. Then the hot gases from the furnace will instantaneously radiate heat into the air tube, and because the heat rays impinge on the surface of the sheet of oxidized iron at the bottom of the air tube, therefore they are immediately arrested and impart their vibrations to the contents of the air tube. Thus, as glass in our windows transmits all the rays of light, so do these plates of rock-salt form, ot doors only, but *windows* for radiant heat.

It is necessary for us now to consider the radiative property of the evolved gases in B, and the absorbent property of the air in the tube A (premising that both these properties are always possessed equally by the same body). First, with reference to the evolved gases, Tyndall has shown that they possess these qualities in an eminent degree, *because* they are compound gases; but this cannot be said of the air in the other tube; indeed, if this air was *quite dry* and *pure*, all the radiant heat would merely pass through it without heating it at

all *until* it reached a surface formed by an absorbent body, such as our oxidized iron, which is capable of receiving the heat vibrations, which receptive surface can then heat the air above it.

Now, as the small amount of aqueous vapour in our atmosphere is the main absorber of radiant heat, thus allowing the diathermanous air to become heated, which heated air can then be conveyed to distant parts by winds ; so also can a minute admixture of the compound molecules of various gases—such as those from coal—greatly promote the heating of air for blast furnaces.

It is evident that in this manner the heat vibrations alone can be transferred from one tube to the other, while their gaseous contents are prevented from mixing. If a revolving fan be the means adopted for circulating the gases, it can be applied to any convenient part of the circuit of either of the tubes A or B. In the figure it is connected with A, and therefore first draws the fresh and heated air, and then discharges it under pressure into a large and broad tube extending *close* along the bottom of the boiler, and thence into a reservoir directly below the furnace and boiler, which supplies the *tuyères* with the heated air. The thermo-convector and connections therefrom are covered with felt, and then cased with tin, leaving an air space between.

The outlet of the tube B conveys the waste and cooled gases downwards over a shallow vessel of water (C), thus arresting the ashes, which speedily sink, and the gases can escape there for locomotives (which would be an important desideratum in tunnels and underground railways), or be conveyed over the ship's side in marine engines, or else made to go upwards through a funnel by the pressure of the blast. This funnel is useful in first getting up the fire, for which purpose the door D is lowered, which then closes the tube B.

As there is a considerable amount of water in some brown coals, and as this would have a tendency to condense in the tube B and thus arrest the ashes, it was necessary to determine the temperature at which its vapour would condense, and I find that if 10 per cent. of water exist in the coal, its vapour will not condense until it is lowered to 27° F., which gives a sufficient margin to ensure a dry exit to the ashes.

It has been shown by Joule and Mayer that the mechanical force arising from heating 1lb. of water 1° F. is equal to raising 772lbs. one foot high. When we therefore consider the enormous quantity of air necessary to promote combustion of the fuel (one ton of coal requiring about 448,000 cubic feet, or more than 15 tons), and, further, that this immense volume of air requires its temperature raising to that of the burning fuel, it is evident that a very great saving can be effected by heating it before it enters the furnace, for it matters not on what part of the absolute scale this 1° increase occurs, let it only be

imparted to a substance at a lower heat requiring it and we utilize the obscure heat, whether it be 1° or 500°, while, at the same time, the luminous heat in the furnace is vastly augmented, and can act quicker by conduction and radiation upon the contents of the boiler.

The bottom of the furnace is made concave upwards, and is formed by the boiler-plate itself, so that the water is brought close to that part where ignition is the strongest, which could not be effected in a furnace with fire-bars. Steam will be generated at this part of the furnace with immense rapidity, for not only have we radiation of the heat, but conduction too. A number of tubes convey the hot blast upwards, in a convergent direction, through this part of the boiler into the furnace, and these tubes or *tuyères*, together with the bottom of the furnace, are kept from overheating by the water in the boiler. To prevent the possibility of the spheroidal condition being imparted to the water from the intense heat, this part of the boiler is roughened internally to facilitate the vaporization and agitation of the water; and, still further to insure safety against explosions and to prevent priming, a certain amount of the evolved gases from B, above the ash-pit, are conveyed into the boiler near this part of the furnace, either directly by a pump, or into the feed water, or else into the distilled water of the surface condenser, if one be used. From the repeated vaporizations and condensations of the water in the surface condenser it is deprived of its air, and its boiling point is thus raised from its increased cohesion; but when it is charged with these gases, which it quickly absorbs, then ebullition takes place from the bottom and from all parts of the boiler, and this at a less temperature and with more regularity.

Fresh fuel is added by placing it between doors in front of the furnace, one of which is shut when the other is opened, which serves to keep it sufficiently air tight when fed, at the same time preventing loss of heat by radiation, and rendering it cooler for the fireman; and sufficient fuel is added so that it falls in the proper form of heap of itself, and covers all the *tuyères* but one to a proper depth. The *tuyère* which is not covered delivers hot air among the evolved gases, and, therefore, instead of cooling them and thus forming smoke, as cold air would, it heats them and ensures their combustion; and this is effected without cooling the sides of the furnace and boiler. If the fuel be lignite, it will not need stirring, neither will there be any clinkers formed to need removing.

The use of the blast allows the furnace to be made smaller, and because heat varies inversely as the square of the distance, it is obvious that intensity of evaporation of the water is increased by being brought nearer to the centre of heat; and because the density or elasticity of the air is diminished one-half for an increase in temperature of 491° F., therefore it will require discharging

under double the pressure of a cold blast. From the increased diffusibility of these gases, it follows that the boiler tubes can be reduced in diameter, and consequently made thinner with safety; and, as combustion is rendered complete, there will be no smoke to deposit soot in them.

The advantage to be derived from the use of a hot, in place of a cold, blast is clearly proved in a series of blow-pipe experiments made at the laboratory of the Geological Survey of New Zealand, and published in Vol. II. of the "Transactions," where it is shown that such refractory substances as platinum, fire-clay, flint, pipe-clay, agate, and opal, were fusible if air at a temperature of 500° F. be employed. And with an exalted intensity of heat in the furnace, we are enabled to avail ourselves to a still greater extent of the economy arising from both the super-heating of the steam and its subsequent expansion in the cylinders of the steam engine.

Description of Plate.

A The air tube, the top of which supplies the blower E.

B The tube containing the gases of combustion.

C Ash pan, containing water.

D A door which can drop and close the tube B.

G A tube, or space, the full width of the thermo-convector, through which the waste and cooled gases can be discharged upwards to the funnel.

E The blowing apparatus supplied with the fresh heated air from the top of the tube A, by means of a space similar to G, and which fills in the front of the convector, but is removed in the figure in order that the interior can be seen.

H Reservoir of hot air.

J Water space of boiler perforated by the air tubes.

K Fire doors, enclosing space holding a charge of fuel.

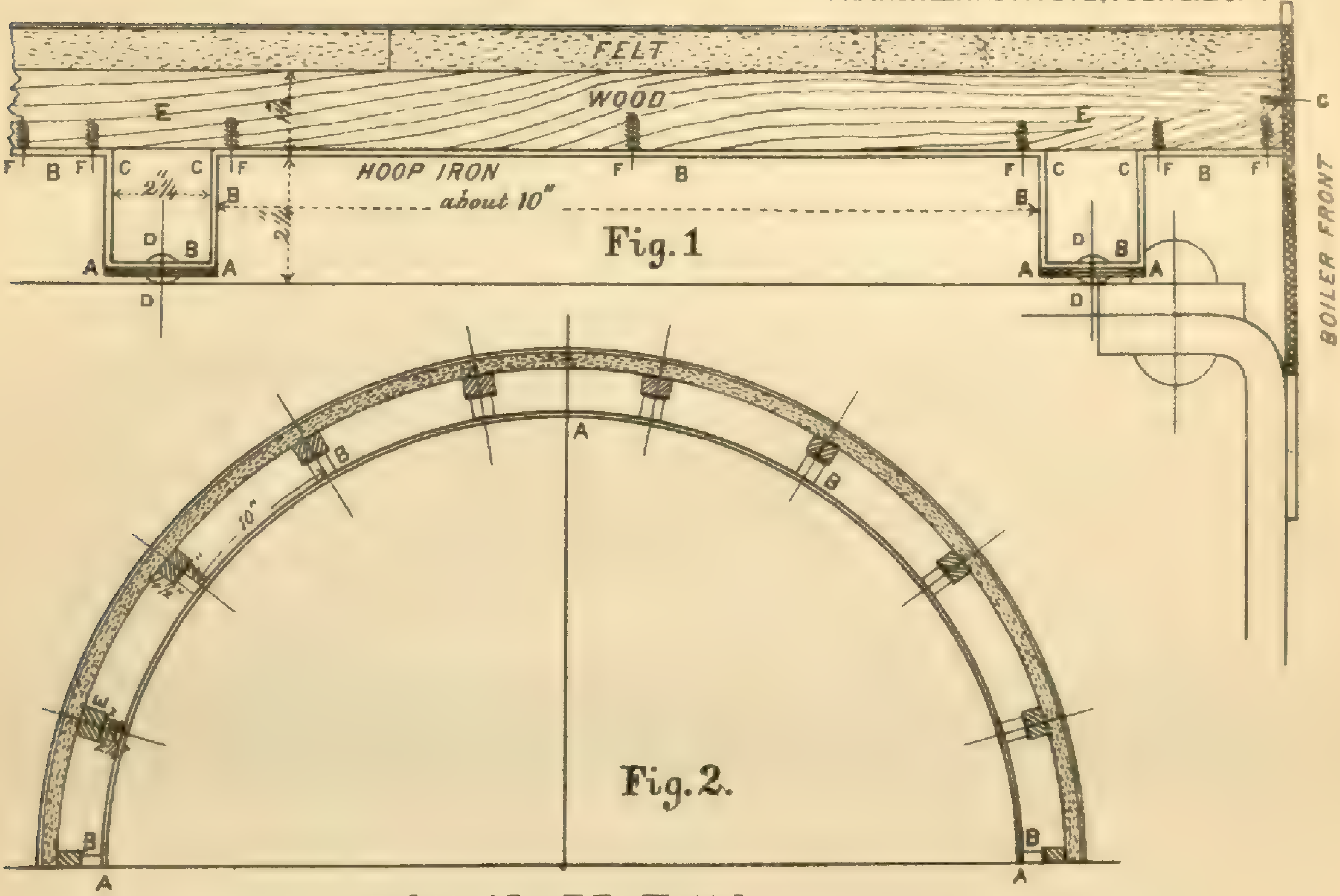
Art. V.—*On the most Economic Mode of Felting Steam Boilers.*

By J. C. Firth.

(Pl. V., figs. 1 and 2.)

[*Read before the Auckland Institute, 6th October*, 1873.]

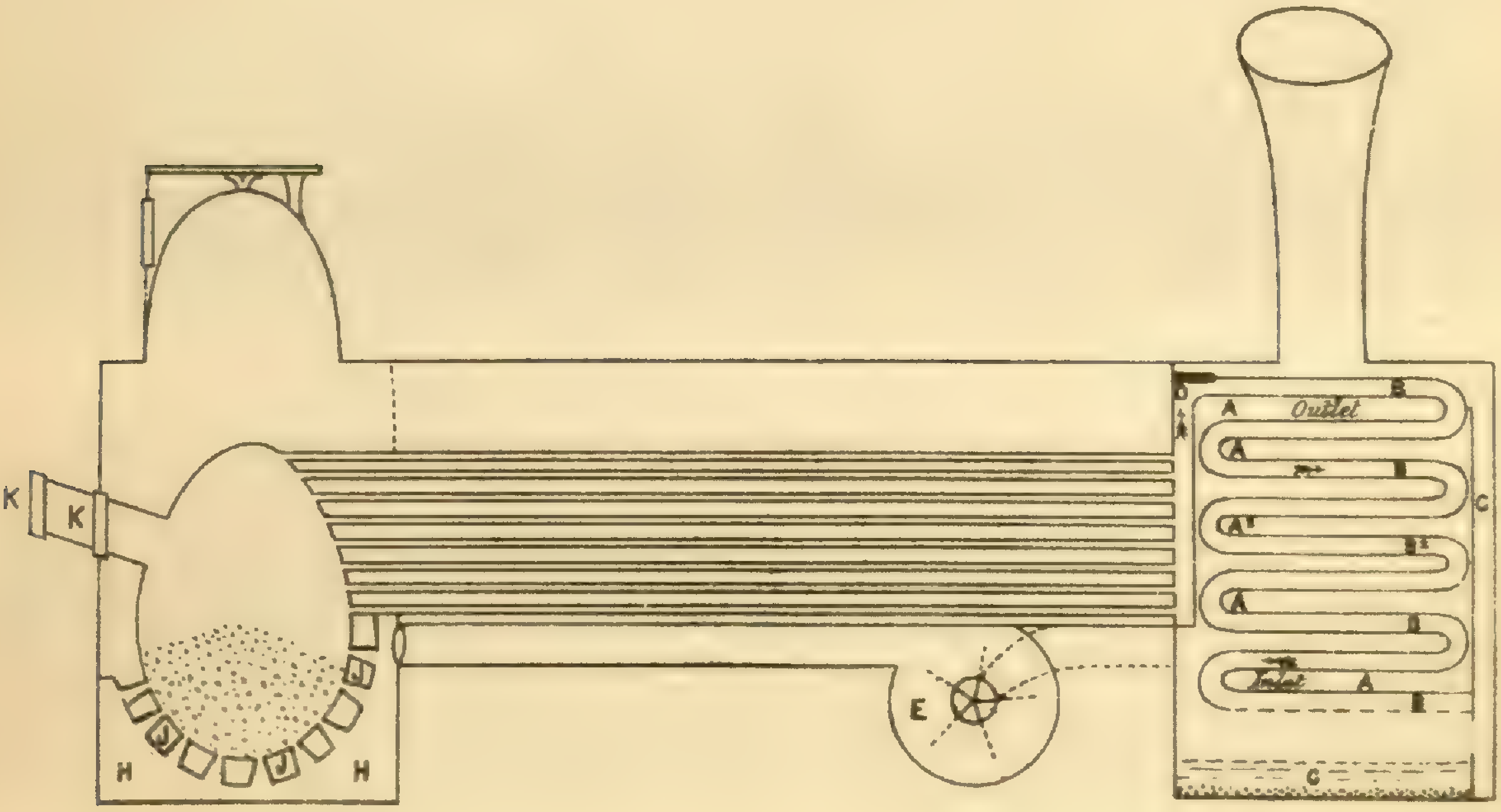
During the period when low-pressure condensing steam engines were in general use, various plans were adopted to prevent waste of steam and heat in boilers by condensation or radiation. With boilers at 10lbs. to 15lbs. pressure, a simple covering of felt, protected by wood or canvas, answered sufficiently well. But when steam boilers are run, as at present, at 50lbs., 75lbs., or 100lbs. per inch, for working steam expansively, or for working compound engines, it has become much more important that the surface of a



BOILER FELTING

TO PREVENT BURNING AND RADIATION OF HEAT.

Illustrating Paper by J. C. Firth.



SMOKELESS FURNACE.

Illustrating Paper by H. Skey.

boiler working at these high pressures should be so protected that heat and steam may not be wasted by radiation or condensation.

It is true that common felt cased with bricks will prevent much condensation and radiation, but with the serious disadvantage that a leakage from a rivet, or otherwise, causes rapid corrosion when running unobserved under the brick casing, and with the further disadvantage that the felt is destroyed in a very short time.

Various materials, such as asbestos, cloth, or fabrics saturated with chemical preparations, have been tried, but, so far as my investigations have gone, much the best material yet discovered is common felt.

The proper application of felt has been, and I believe still is, the real difficulty. Applied in contact with the surface of a steam boiler at even 50lbs. pressure, felt will need replacing about once in six months. About two years ago, to lessen this destruction of felt, I made a species of hurdles or gridirons of common hoop-iron, with wooden battens of 1 in. thick rivetted to the hoop-iron. These were placed upon the boiler, and the sheets of felt laid upon them, the upper surface of the felt being protected by canvas. This plan secured a small space between the boiler and the felt, but, though a great improvement upon the old plan, I found that in the course of about fifteen months the wooden battens had become charred and the felt a stratum of dust, slightly adhering, indeed, to the canvas back if undisturbed, but practically useless. Both substances had simply been destroyed, as before, by too close a contact with the boiler.

A very simple contrivance now presented itself to my mind, which I immediately put in operation. I constructed an iron grid as before, but with one important difference. I placed pieces of hoop-iron AA (Figs. 1 and 2) at 10 in. distance, to lay on the circumference of the exposed portion of the boiler. I then prepared transverse pieces of hoop-iron BBB (Figs. 1 and 2), putting two double cranks in each CC (Fig. 1) $2\frac{1}{4}$ in. high × $2\frac{1}{2}$ in. wide. I placed these transverse pieces at 10 in. distance, and rivetted each of the cranks at D (Fig. 1) to the pieces of hoop-iron intended to lay on the circumference of the boiler. When cranked, the transverse pieces were 21 in. long, about the width of an ordinary sheet of felt. Upon these cranked pieces I placed wooden battens 2 in. broad by $1\frac{1}{2}$ in. thick EE (Figs. 1 and 2), screwing them together at FFF (Fig. 1). This completed the hurdle, or grid, 21 in. wide, and of sufficient length to lay across the boiler from side to side. I next provided sheets of felt long enough to cover each grid, sewing each sheet to strong canvas 24 in. wide, thus leaving at one side a margin of canvas to lay over the sheet of felt on the adjoining grid. The 4 in. air space (which may be increased at pleasure by increasing size of cranks) between the boiler and felt, besides preventing all charring of wood or felt, is an excellent

non-conductor. To prevent a circulation of cold air from end to end of the boiler, I attached a piece of sheet-iron, cut to the circumference of the boiler, to the ends of the battens on the grids at each end of the boiler G (Fig. 1). A coat of paint on the canvas completed the apparatus.

I exhibit a full-size section of one of the grids, with felt and canvas attached, to be placed for reference in the Museum of the Society at Auckland. I have attached the felt to the grid in this section to show the apparatus complete ; but, in practice, the felt and canvas only are attached to each other, but not to the grid, so that each can be stripped from the boiler without difficulty.

I come now to results. I find that loss by radiation and condensation is reduced to a minimum ; the canvas covering of the boiler being always quite cool, with steam at 50lbs. As an instance, I may mention that when the engines stop at 6 o'clock p.m., with steam at 50lbs., with the felt on, at 6 o'clock next morning steam is about 25lbs. ; without the felt, steam goes down to *nil* before 6 o'clock next morning, the dampers being in both cases the same. The saving of coal has, of course, been considerable. Nine months have elapsed since I applied this mode of felting at my own works, and I find that both wood and felt are practically uninjured.

Where compound engines are in use, this mode of felting the steam pipes leading from the boilers to the high-pressure engine, and from the high-pressure to the condensing cylinder, will be found most effectual in preventing loss by condensation or radiation, besides being comparatively indestructible. For covering steam domes and engine cylinders it is equally effective. For these latter the grids and felt may be covered with wooden battens, hooped and varnished as usual.

It will be necessary to observe, when covering pipes or other steam chambers of small diameter, that the cranked pieces of hoop-iron must be placed sufficiently near to each other to secure a space of 3 in. or 4 in. between the steam-pipe and felt. In all cases it will be found more practicable to run the pieces of plane hoop-iron round the pipes or cylinders to be covered, running the cranked pieces longitudinally, as already described in the case of steam boilers.

ART. VI.—*On the Probability of a Water Supply being obtained for the City of Auckland from Mount Eden.* By JOHN GOODALL, C.E.

[*Read before the Auckland Institute, 10th November and 8th December*, 1873.]

AUCKLAND, advantageously situated as it is on an isthmus between two fine harbours, the Manukau and the Waitemata, commanding both sides of the island, is rising fast to be a fine city, and will doubtlessly some day be one of the most magnificent in the southern hemisphere. In spite of its many advantages however, it would always remain one of secondary importance if, in its progress, it could not obtain a sufficient supply of water. Happily there is no lack of this needful commodity; perhaps, for the present, it had been better for Auckland if so many sources of supply had not been known to exist, for then the question might have been settled, and the pure element flowing through Auckland, refreshing its inhabitants, purifying its atmosphere by sweeping away all refuse into the sea, saving life and property in the extinguishing of fires, thus adding health and preserving wealth to its citizens.

Had there been only one source of supply, probably that would have been in Auckland by now, as the only delay seems to be caused by not knowing which source to choose, which, after all, is a purely financial question. The various sources are known to be good and abundant, therefore all that remains is to find out which can be most cheaply brought into this town. The Nihotupu gravitation scheme would yield more water than is required at present. The western and Onehunga springs would yield, by pumping, much more than is wanted. Lake Takapuna, North Shore, has also been talked of as a likely source, but the cost of the engineering works requisite for bringing the water over or under the Waitemata would be a sufficient hindrance for that source to be entertained at present.

All these sources, excepting the Nihotupu, arise from the volcanic formation at and adjacent to Auckland, yet this city may at any time be scourged by a pestilence or burnt to the ground for want of an available and sufficient supply of water. These varied schemes have been from time to time propounded by their supporters; it is not the intention of this paper to enter into their various merits, but to bring under notice another scheme which may prove to be as good, and which is close to Auckland, namely, from the scoria and lava beds of Mount Eden.

We all know that in the vicinity of Auckland there is a vast tract of volcanic country, consisting of extinct volcanoes, tuff cones, and lava streams, extending over twenty or thirty square miles. Almost the entire rainfall over this large tract of country is being stored by Nature in the porous lava rocks,

and being served out again through the many springs occurring on the road to the Whau (the Western Springs), at Onehunga beach, Lake Takapuna, and other places. These springs are merely the overflow of what is a natural subterranean reservoir. To prove this, one must consider how volcanic rocks occur, especially those at Mount Eden and its vicinity, and their physical construction.

Dr. Hochstetter remarks about these volcanoes that "the first outbursts, as a closer observation shows, were probably submarine; they took place at the bottom of a shallow, muddy bay, little exposed to waves and wind, and consisted of flowing mud mixed with loose masses, such as fragments of sandstone and shale, lava *debris*, cinders, and scoria (*lapilli*), which now form beds of volcanic agglomerate or tuff. The eruptions occurred, no doubt, at intervals, for in this manner alone can the fact be accounted for that the ejected material has been deposited round the point of eruption in layers one above the other, forming low hills gradually rising, and with a circular basin or dish-shaped crater in the middle; a cross section presents clearly the different layers which usually slope inwards towards the bottom of the crater, as well as outwards down the sides." Further on, he says:—"A complete volcanic system accordingly consists of three parts: a tuff cone the base and pedestal of the whole frame, a lava cone, the chief mass of the mountain, and a scoria or cinder cone forming the top, with the crater."

These violent outbursts and ejection of such large quantities of scoria and lava would undoubtedly produce very important effects on the surrounding country and on the rocks immediately below and through which the eruptions occurred. Before a vent could have been made through the earth's crust, it must have been somewhat upheaved and cracked to emit the molten materials below, which, as they ascended, would have enabled the crust to subside, and this it would continue to do as long as material was ejected, for the earth's crust, by its own weight and that of the piled-up scoria and lava above, would necessarily sink down and occupy, in a measure, the place of the ejected materials. Thus, below a volcanic mountain of any considerable extent, there must be a basin-like depression immediately beneath capable of holding a large quantity of water, which, combined with the water in the mountain above, retained in it as if it were a large sponge, may probably be made available for a water supply. But as the quantity in the basin and above it may be inadequate for a large supply, we must consider whether this may be helped by the adjacent waters stored up all around. An inspection of lava and scoria beds prove that they are able to hold a large amount of water from their porosity, dependent upon the amount of resistance to dam the waters back.

Before it can be decided whether a sufficient quantity of water could be

obtained from Mount Eden, it will be necessary to prove the depth of the basin or floor of the volcano, its shape, height of the rim of the basin at its lowest part, probable direction of the flow of water from it, summer level (minimum) of water, and inclination of the water from the rim of the basin to its outlet at the springs.

A part of these questions may be answered by a survey of the ground, and by obtaining levels—that is, by surface examination; and the entire question would be solved by adding to the above a series of bores. A survey of the ground would determine the probable shape of the rim of the basin, also the course of the water travelling beyond the rim. The lava streams having run in the old valleys formed by the tertiary rocks, indications may yet be obtained of the course of the bottom of that valley by the run of the lava and other indications, such as the outcropping tertiary formation; and, as the overlaying lava rocks are of a very porous nature and abounding in large cracks and cavities, any water pouring from the hills above (after rain) would undoubtedly flow through the ancient valley, but would occupy more space, have a greater inclination, and would take more time to flow than were it unimpeded.

Having completed the survey, it will then be advisable to put down a series of bores between the site of the reservoir at Gilfillan's corner and Mount Eden. These bores, put down between the limit of the scoria and half way to the centre of the hill, would probably be sufficient to give the depth and shape of the basin. This will be important to ascertain accurately, as on that side the necessary shaft would be sunk, and a correct knowledge alone could be a guide as to the depth of shaft and distance of a drive to tap the water. Then, at a point to the westward of the hill facing the lava flow, another series of bores should be started, beginning at about half-way down the hill, over the rim of the basin, and thence along the probable course of the subterranean stream to its outlet at the springs. These bores would determine the depth of the basin, the permanent level of water, and the inclination of the water towards the springs. Having all these *data*, it can now be calculated, without much trouble, what available water there is; and by the height of the rim of the basin may be determined how much extra supply can be obtained from the outward flowing stream; for the lower the rim is, the better will it be, as then, by pumping at Mount Eden, any insufficiency of water in the basin would be supplied by infiltration. Having arrived at this stage, it can be positively ascertained if there be an adequate supply or not; and, if there be, a shaft will have to be sunk, and pumping machinery erected for supplying the reservoir.

There are two available sites for a shaft, one being at the proposed reservoir. If this be fixed upon, the shaft should be sunk to the level of the bottom of the basin under Mount Eden, unless that exceeds high-water mark,

in which case the shaft need not be deeper; from the bottom of the shaft a drive should be put in towards Mount Eden, till the lava or scoria beds are reached, when an abundant supply of water would be sure to be met with. This, flowing through the drive to the bottom of the shaft, would be pumped up into the reservoir. By this method no piping would be required for transmission of water to the reservoir, beyond that necessary for the pumping mains.

The other site, and perhaps the better one, would be by the side of the proposed railway to Riverhead, at the bottom of the valley between the proposed site of the reservoir and Mount Eden. The advantages here would be, that the railway would be available for carriage of machinery and other material necessary for the erection of works, and coals would be cheaply conveyed for boiler purposes. The depth of this shaft would be less, and the drive towards the basin would be materially shortened, which latter advantages alone would compensate for the pipes which will be necessary to convey the water to the reservoir. The shaft, in this case, would probably penetrate a layer or two of lava: it will be advisable to avoid it as much as possible, to save cost, and sink on the verge of the lava, and thus get all the shafting and driving through the soft tertiary rocks.

That water may be obtained from Mount Eden is already proved, independently of theory, by the success of Mr Seccombe's well, which supplies his brewery on the Kyber Pass Road. This well is only a moderate depth down.

There is yet another point to be touched upon, and that is, the volcanic cracks in the earth's crust, which must necessarily exist with a series of volcanoes such as occur here; for it is probable that, after the first outburst, other volcanoes started along the cracks, and the number kept increasing till the number of vents created were sufficient for the emission of the pent up gases and molten lava. Perhaps it is owing to the large number of volcanic centres that have existed near Auckland, that they have been so short-lived, and that none of them are now active—many have been the fires, but they have burnt themselves out the sooner. That the cracks existing between these craters are capable of acting as water channels is proved by the existence of Lake Takapuna (an old crater), North Shore; for how otherwise can this lake be supplied with water than from its connection with other volcanic centres? To test this, a drive should be started from the pumping shaft at right angles to a line between two craters; this would be sure to cut the connecting channel between them, and drain them of their waters and others connected with them, and who knows but we may yet bring Lake Takapuna waters into Auckland by this means.

The advantage of using these volcanic waters (if we may term them thus),

provided always that experiments have satisfactorily proved them to be available; the cheapness with which they can be utilised, being so close to the proposed reservoir, and the waters being so pure, there will be no necessity for settling-tanks or filters.

Having shown that Mount Eden contains a large quantity of water, and sketched a scheme whereby the same might be proved and rendered available for supplying Auckland, I will now make a few remarks as to its sufficiency and probable cost.

Supposing that the basin under Mount Eden would draw its supply of water from an area of about five square miles, and accepting twenty-four inches of rainfall as available, it will give the large yield of four million five hundred thousand gallons per day; or, reducing the yield to one-fourth of that quantity to allow for any over-estimate of the area of the gathering ground—it being impossible at present, without boring and other investigations, to determine the exact area of supply—there would still be left over one million gallons per day, which would be more than sufficient to supply thirty-three thousand inhabitants with thirty gallons daily per head. These results depend entirely upon the depth and circumference of the basin, which, when ascertained, will give reliable *data.*

It seems natural that by pumping at the centre of such a supply, before it had time to distribute itself, the full amount of rainfall percolating through the gathering area may be raised, and a larger quantity could be obtained than from a similar area at the Western Springs, or from those at Onehunga, where only comparatively small quantities flowing in particular directions can be used, the natural outlets being numerous.

The cost of such a scheme would be less than one from Onehunga or from the Western Springs, as not only would a great saving be effected in transit pipes, but also in cost of pumping, as the water might be obtained at a considerably higher level than at either of the above-mentioned places. By examining the level of the outflow of the water at the Western Springs and the water standing in a well sunk by Mr Edgecombe—the distance between these two places being about a quarter of a mile—it will be found that the latter level is twenty feet above the former, which would give a rise to the centre of Mount Eden of about one hundred feet. This evidence is further corroborated by the large quantity of water obtained at a high level in the well of the Northern Brewery, on the Kyber Pass Road.

The height to which the water would have to be lifted would be under two hundred feet, to a reservoir at Gilfillan's corner, which point is nearly three hundred feet above the sea level.

The cost of plant capable of raising a million gallons daily will be as follows:—

Engines, boilers, engine-house, workmen's cottages	£10,000
Mains (including laying), 70 tons at £15 10s.	1,085
Shaft, 100 feet	500
Drive, say	500
Air cocks, check valves, etc.	250
Reservoir	3,500
	15,835
Contingencies, 10 per cent.	1,583
Total expenditure	£17,418

The yearly cost will be:

Wages, coals, oil, etc.	£1,860
Interest, at 8 per cent.	1,393
Annual expenses	£3,253
Cost per million gallons	£8 18s. 3d.

Art. VII.—*Notes on the Proposition to Supply Auckland with Water from Mount Eden.* By James Stewart, C.E.

[*Read before the Auckland Institute, 8th December,* 1873.]

At last monthly meeting of this Society, Mr. Goodall read a paper in which the above proposition was pretty fully set forth, and a scheme for testing its feasibility stated in detail. This is not, by any means, a new idea, as about eleven or twelve years ago it was proposed as original, and advocated with other three schemes for the same purpose. One of the schemes was, in sober earnest, a proposal to impound the water flowing down the valley of Newton, from the cemeteries; and the advocacy of the Mount Eden one showed equally the absence of all engineering thought or study. Mr Goodall's paper dealt with it differently, and in a clear manner stated a method of testing the level and area of the supposed water basin. One grand point was, however, overlooked, just as the earlier propounder had done. While the existence of water in wells near the base of Mount Eden is undisputed, and that at a tolerably high level above the sea, there is no attempt to show that there is a source of supply at all adequate to the demand. It is not only necessary to show a reservoir of water, but how much may be daily and yearly drawn from it without failure must also be demonstrated. Two lines of evidence are required to show the latter point in this case. Firstly, the discharge of the

water from the presumed basin, and, secondly, the source from whence it is drawn. In ordinary gathering grounds, the first of these only would be pretty conclusive, although the second would always be required and given as corroborative evidence. There being no visible overflow which would be anything like an adequate supply within more than two miles, or nearer than the Western Springs, we must look to the source of supply, and compare it with that discharge.

The Mount Eden cone has been thrown up nearly in the centre of a tufaceous basin, which is now incomplete, although distinctly traceable on several parts of its circumference. Towards the east the tuff crater has been washed away, or broken through by the solid lava streams on which Newmarket stands; the clay is 12 ft. to 18 ft. below the level of that place, and it is important to note that it is at very nearly the level of that clay at which water is found in the wells at Messrs. Seccombes' brewery and at the gaol. We have no means of knowing the exact area of the annular space between the lip of the tuff crater and the central aperture from which the lava was, subsequently to the elevation of the tuff basin, discharged. But from the enormous masses of lava ejected in many successive eruptions, and in nearly all directions, the annular water-holding area must be very small, and cannot be looked on as being more than half a square mile. It is needless to remark that such an area, or double that area even, is wholly inadequate to serve as a gathering ground.

Thus far have we considered the supply from rainfall. It is true that, in dealing with these lava cones and their so-called mysterious springs, many do not look to local rainfall as the source, but boldly scan some distant lake, and, totally ignoring the laws of gravitation and those regulating the flow of water, as well as the seemingly insuperable difficulty of intervening seas, point to a probable subterranean connection and source of supply. Such a connection between Mount Eden and Takapuna Lake is hinted at in the paper calling forth these remarks, and not a few have expressed belief that the rainfall of Rangitoto is the source of the waterflow from that same lake. Now, it seems the result of an exceedingly strong imagination to conceive that water falling on a mountain like Rangitoto, composed of scoria extending into and below the level of low water, should find its way to any place but the sea; or why should the very limited overflow from the lake suggest any other source than the area of its surrounding basin?

But to return to the subject of enquiry, the outflow at the Western Springs represents with certainty that of several thousand acres, as at that locality only has the tertiary formation permitted the lava to reach the sea, which was ejected from Mounts Eden and Albert to the northward. The rainfall on that area, not evaporated or retained by soil and vegetation, must be that

overflow which wells up so grandly; and many underground rivulets, following ancient valleys in the tertiary clays, must be convergent to form those noble springs. And the farther inland at which water is sought, the smaller and further apart will be those rivulets, until, on reaching the summit of the watershed at Mount Eden, the minimum will be attained; and, although at that elevation a basin may be found containing many million cubic feet of water, it would only be a work of time to exhaust it if the all-important points of rainfall and gathering ground are inadequate to keeping up the supply.

Art. VIII.—*On the Reclamation of Sand Wastes on the Coast, and the Prevention of their Inland Advance.* By James Stewart, C.E.

[*Read before the Auckland Institute, 4th September,* 1873.]

The existence of a very serious evil will be recalled to mind by perusal of a carefully-considered paper on the above subject, by Mr. C. D. Whitcombe, as given in the last volume of the "Transactions,"* especially by those who have had occasion to notice the increasing and apparently resistless advance of sand inland from a great length of our coast line. In places this is covering the fairest and most fertile soils, burying forests, and driving before its dread advance all the efforts hitherto made by a few individuals more immediately concerned to ward off or retard its progress. The subject claims public attention, as not only has a very large tract of country been lost to settlement already, and many fertile farms are now being threatened with annihilation, but, as is shown in the paper referred to, and well remarked during the discussion on it, the existence of streams, the navigation of rivers, and safety of lighthouses, and such like, are concerned in the adoption and success of preventive measures. This attention, if it is to be at all, cannot be awakened too soon.

The features presented by this encroachment vary on different coasts, but it will suffice to describe those nearest to Auckland. Those are, the coast from Waikato to Manukau Heads, and from Waitakerei to Kaipara Heads. The former is, where uncovered by driving sand, of a very fertile nature in general. It is a rich sandy loam—in some places an excellent black soil—throwing up a good pasture, and carrying a stock of, in some cases, the heaviest cattle which come into the Auckland markets. The land is very easily brought into cultivation, and is about all taken up, and much of it settled on.

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* Trans. N.Z. Inst., Vol. V., p. 108.

Perhaps the best idea of the evil which threatens this fair district may be had by a journey from Waiuku to Port Waikato. As the traveller advances in this direction, the land is seen to change from the heavy clay lands at Waiuku to lighter and more loamy soils. When the distance is about half traversed—and the road lies generally parallel to the coast—the advance-guard of the sand-drift is seen covering half of what was not long ago a field of rich pasture. At the southern boundary of the Maioro, a village site with a few houses and small farms is reached, and the advancing sand-hills and drift are only a few yards to the westward of them. Close brush fences have been erected with the view of protection, but that is only a most temporary remedy, and nothing hitherto done is of any avail. From this point the traveller strikes into the desert, and for about four miles, to the Waikato Ferry, traverses such a waste as few imagine can be witnessed in New Zealand. Nothing but sand is in sight, and, may be, the tops of trees long since buried. This desert stretches farthest inland just at the river, and does not extend south of it, if we except the flat between the bar and the southern cliffs, which has been formed by an enormous landslip causing a change in the course of the river about three-quarters of a mile to the northward of where it formerly flowed. On this landslip the township of Port Waikato is now laid out.

A small portion of the coast between Waikato and Manukau Heads is still unbroken on the surface, and in many places the first eroding action of the wind is to be observed. The South Head is a striking example of this. Within the last few years many millions of tons of sand have been carried out into the channel of the southern passage of the bar. A remarkable feature on the coast is that of blind gullies, two of which are to be seen near the Manukau South Head. The principal one must drain at least 800 acres, half of it being heavy bush land, but its outlet is covered by a hill of sand 480 feet high, through which the water filters to the sea.

The Kaipara sand-hills differ from the above described, inasmuch as that while in the latter case the sand is encroaching on a rolling country of nearly its own level, in the former the encroachment is tumbling inland over, for a great part, a country of much lower level, and will soon reach extensive plains but a few feet above high water. The advance is consequently very slow, but none the less sure, and, if not arrested, eventually the Kaipara river itself will be choked.

In considering the possible remedy, one point has certainly been determined, although only of a negative character. It is quite useless to begin inland. Neither fence nor trees can arrest the drift. When a brush or other close fence is erected in the sand it certainly seems to have immediate effect; the force of wind is checked near to the surface, and sand ceases to be carried forward and deposited within a few yards of it, but soon a ridge is formed to

windward, where it ceases to have onward motion, and, rising higher and higher, its leeward side towards the fence soon shows a face as steep as the material will allow of. The drift still rises, and the crest rolls over the steep side, continually approaching the fence, until at last it is buried. A forest has the same effect and ultimate fate. Of what use, then, is planting young trees, if fences and old "bush" are of so little avail? But the same experience shows that if the drift can be arrested at its source, then all to leeward may be gradually worked on and reclaimed.

There can be little doubt that these hills have been originally blown up from the sea sand, but this has been most likely during a gradual elevation of the land. The closing in of the valleys above mentioned with nearly 500 feet of sand seems conclusive on that point. But it is most unlikely that any reinforcement of sand is now got from the beach. The hills in general rise 100 feet to 300 feet abruptly from high-water mark, and the drift does not appear to rise much above the surface. The face of the coast then, and the tops of the first hills, are the places where, if anywhere, an effectual start can be made to arrest the evil.

In Mr. Whitcombe's paper much valuable information is given as to the methods found successful in France, and a record is given of the plants and trees found most efficacious. But it seems in the case of the hills under reference in our Province, that the violence of the south-west winds is such that it would not prevent any shrubs or trees from having the sand blown from under them, unless it is first protected by a sward of some grassy sort of vegetation. The effects of the prevalent winds are strikingly indicated by the appearance of the "bush" near the Manukau South Head. The prevailing timber is puriri, and the branches and foliage look as if shorn, and have a singular overlapping appearance, one tree with another, as of a roof shingled and lapped the wrong way.

The reclamation of the Surrey Hills, in Sydney, is a case in point. There the sand was of a nature even less adapted to support vegetation, being sharper and more suitable for builders' use. Yet these heights, which not long ago were a waste of driving sand, are now covered with a beautiful sward of grass. The means in detail by which this was accomplished is unknown to the writer, but he has a recollection of hearing a description of a method adopted in some of the Western Isles of Scotland, and which was successful. There the difficulty was, as with us, to keep the seeds of the grasses stable sufficiently long to allow of germination and striking root. The grasses selected were, when seeded and ripe, spun into hay ropes without threshing. These ropes were pegged to the sand all over the area to be reclaimed, in chequered lines. The seed was thus enabled to germinate and take firm hold, and soon the whole was an uniform mass of vegetation. Such a process is

well worth a trial, and the necessary modifications in our circumstances would soon be ascertained. If our friends learned in those things will indicate such littoral grasses as have the properties of root-spreading and, at the same time, striking moderately deep into and flourishing on nearly pure sand, the practical result cannot be very uncertain, nor the application difficult. It is, in the first place, only a carpet of any sort of vegetation which will prevent the driving of the surface that is wanted. This will allow the planting of trees, and, where the soil is the more suitable, proper pasturage grasses can afterwards be substituted. But the great result would be attained if even the onward progress of the sand was arrested, and, as it must evidently be commenced at the sea, every year's delay loses not only so much more land now good, but increases the width of waste to be reclaimed in order to preserve the remainder.

Art. IX.—*Notes on the Plants best Adapted for the Reclamation of Sand Wastes.* By T. Kirk, F.L.S.

[*Read before the Auckland Institute, 6th October,* 1873.]

As attention has been drawn to the importance of preventing the further inland extension of our coastal sand wastes by the recent papers of Mr. Whitcombe* and Mr. Stewart,† it seems desirable to point out the various indigenous and exotic plants available for the purpose, and to state their respective advantages and disadvantages so far as demonstrated by actual experience or close observation.

Mr. Heale has well shown that, as a general rule, it will be found much more difficult to reclaim the sand wastes on the west coast of the North Island than those on the east, on account of the greater set and force of the wind on the former. While assenting to the general truth of this statement, I am led to the belief that in all except perhaps a few peculiar localities, the object sought may ultimately be obtained by commencing the work of reclamation at high-water mark, since the added sand, except in the case of moving sand-hills, is chiefly derived from the space between tide-marks. If, therefore, we can succeed in arresting this at the extreme verge of high water, the mass will accumulate so slowly, owing to local eddies and coastal dispersion, as in most cases to admit of the growth of arboreal vegetation forming a permanent barrier.

When the sand is but slightly exposed to the action of the wind, the process is very simple, or rather a number of simple processes may be adopted.

* Trans. N.Z. Inst., Vol. V., p. 108. † See Art. VIII.

Where young plants of the marrem or the lyme-grass can be procured, they may be placed about fifteen inches apart, by simply making an incision with a spade, inserting the plant, and pressing the adjacent sand about it with the foot. *Festuca littoralis*, which is common all round the coast, might be used for the same purpose ; *Poa australis* var. *lævis*, an abundant grass from Port Waikato southwards, is also available, as are the pingao (*Desmoschœnus spiralis*) and the *Spinifex hirsutus*, which may be obtained in unlimited quantities on all coast sand-hills in the colony, although they are not so effective as the marrem, lyme-grass, and maritime fescue.

Zoysia pungens, a creeping rooted grass, but with herbage rarely exceeding two inches in height, might be sown or planted amongst the larger kinds ; its herbage is succulent, and it is eaten with avidity by sheep and horses, while it forms a remarkably dense, compact sward. *Poa breviglumis*, a grass more common on sandy shores in the South Island than in the North, affords a larger yield of herbage, and may be either sown or planted. Other suitable plants for this purpose are mentioned in the appended list.

In a few exceptionally quiet spots, grasses of a more nutritive kind might be sown at once : the rat's-tail, or chilian grass of the settlers, the doab grass, buffalo grass, and the common meadow grass are well suited for this purpose, alike from their creeping roots and dense yield of herbage. The sheep's fescue grasses are also of great value.

The plan of forming ropes of seeded hay, and fastening them on the sand, has been described at length by Mr. Stewart, so that I need not refer to it here.

In spots where moisture percolates through the sand for a portion of the year, the common water-cress might be sown or planted ; even if the supply of moisture failed during a protracted drought, the matted roots and decaying herbage would prevent the surface from being disturbed by the wind, and the plant would start into luxuriant growth with the first showers.

In partially-sheltered valleys amongst sand-hills—such, for instance, as are found near the Manukau Heads—it might be worth while to try the experiment of sowing wheat with subterranean trefoil and the native *Poa breviglumis.* A small yield of grain might be expected, but the benefit to be derived would arise from the decaying roots of the wheat, and subsequently of the trefoil, affording additional nourishment for the meadow grass, so that a compact sward would be formed more speedily than by the ordinary method.

But in all cases, in order to afford protection at the most vulnerable point, it will be advisable to plant a belt of coarse-growing plants or small shrubs capable of enduring the spray of the sea at high-water mark. This should be of several yards in width, varying according to the nature of the situation, degree of exposure, etc., and may be composed of toe-toe grass (*Arundo conspicua*),

prickly toe-toe *(Cyperus ustulatus)*, and sea spurge *(Euphorbia glauca)*, all of which are abundant on the coast, and in many places may be planted without subdivision. The sea mallow *(Lavatera arborea)*, of which seeds may be collected in the neighbourhood of every New Zealand port, would form a valuable addition to the native plants adapted for this purpose.

In places but little exposed to the wind it would not be absolutely necessary to introduce shrubs or trees, although such a course offers many advantages. The osier and the white willow are well adapted for such localities, and may be readily increased by cuttings, so also the weeping willow, the sea buckthorn *(Hippophae rhamnoides)*, the pohutukawa, ngaio, and others to be presently mentioned. The best of all known trees for this purpose, however, is the pinaster, but plants not more than one or two years old should be used; in the latter case they should have been transplanted the first year.

But the process is not quite so simple in localities exposed to the full action of the wind: here it is imperative at the outset to provide temporary protection by covering the surface with branches of evergreens, straw, rushes, reeds, etc.; or by erecting a stout wattled fence; by thatched hurdles; or, best of all, by a fence of close boards. In not a few spots it will be necessary both to erect the fence and to cover the surface with branches, or the most available substitute.

It is obvious that under such circumstances planting cannot be undertaken to any great extent, and must be restricted to spots where it is absolutely necessary, and to such objects as creeping-rooted grasses, etc., some of which will not only endure the diminished amount of light and air caused by the overlying branches, but will, for a time, derive considerable benefit. But as grasses alone, even if thoroughly established in such exposed situations, would soon become buried by the moving sand, it will be necessary to employ trees and shrubs to a large extent; and these can only be established by sowing, which is happily the most economic method. The most effective plan would be to commence at high-water mark, and erect a fence, as already suggested, at right angles to the prevailing wind; then to sow a belt with the seeds selected, which should be immediately covered with overlapping branches of evergreen trees, lightly pegged down, or secured with stones. The width of the belt must depend upon the violence of the wind, degree of exposure, etc.; but too much should not be attempted at once. This belt of itself would, in a short period, form a shelter for another belt, and so on until the entire area was reclaimed.

The best mixture I can suggest for general purposes of this kind in the Colony is:

1 lb. broom *(Spartium scoparium)*.

1 lb. pinaster *(Pinus pinaster)*.

½ lb. tarata (*Pittosporum crassifolium*).
½ lb. cottonwood (*Cassinia leptophylla*).
1 lb. toe-toe (*Arundo conspicua*).
2 lbs. buffalo grass (*Stenotaphrum glabrum*).
½ lb. sea meadow grass (*Poa breviglumis*).

The above would be sufficient for one acre. The selection might be varied by substituting any of the plants enumerated hereafter, at the judgment of the cultivator.

As before remarked, it would be advantageous in all cases to plant at high-water mark a broad belt of toe-toe, prickly toe, sea spurge, and sea mallow, or similar plants, of which we have happily a fair choice; also, if practicable, to plant roots of maritime creeping grasses amongst the seeds when sown.

The broom would attain a height of two feet or more the first season, but the pines would not exceed a few inches. In the north the pines would probably overtake the broom and other shrubs about the fourth year, by which time they would require thinning, and the thinnings might be used to protect other sowings. As the thinnings became larger the trunks and roots might be burned for tar and charcoal. In about eighteen or twenty years the trees might be tapped for resin, when the supply would increase yearly. Unfortunately the timber is not so valuable as that of *P. sylvestris* and other species, although in Central Europe it is used for inside work and for shingles.

The following enumeration of plants adapted for the reclamation of sand wastes is by no means exhaustive. Several Australian and Tasmanian species besides those named would, doubtless, prove available, but my limited knowledge of them does not warrant their inclusion in this list. A Tasmanian *Spinifex* growing on coastal sands is said to be a great hindrance to travellers, and may be expected to prove especially valuable for our purpose.

The native country of non-indigenous plants is stated in all cases.

A—Trees and Shrubs.

Pittosporum crassifolium, sea-side tarata, or kihihi.—A fine shrub or small tree, sometimes attaining the height of twenty-five feet; common on sandy and rocky coasts, from the North Cape to Poverty Bay; produces seed freely; a most valuable plant.

P. umbellatum.—Of less value than the preceding; seeds freely.

Dodonæa viscosa, akeake.—Common; on the sand forms a dwarf twiggy shrub; seeds freely.

Corynocarpus lævigata, karaka.—A handsome evergreen tree, but will not flourish when exposed to the wind; seeds freely.

Metrosideros tomentosa, pohutukawa.—On sandy and rocky coasts, Auckland.

A fine tree with tortuous spreading branches, endures the sea spray; timber of great value for shipbuilding. This tree and the kauri have contributed so greatly to the prosperity of the Province of Auckland that it is surprising to find no steps have been taken to perpetuate the supply. Seeds are produced freely.*

Leptospermum procumbens.—Australia.—This is stated by Baron Ferd. von Müeller to be of great value for covering sand-hills. I am not aware that it has been introduced into New Zealand at present.

Coprosma baueriana, angeange.—Common on the coast.

Coprosma petiolata.—Common.

Much-branched shrubs or small trees; endure wind and spray; cuttings root easily, and seeds are produced in abundance.

Myoporum lætum, ngaio.—Common on all the coasts, and readily propagated by seeds and cuttings.

Hippophae rhamnoides, sea buckthorn, Europe.—Seeds; a branched shrub 2 – 10 feet high, with silvery foliage.

Salix caprea, sallow, Europe.

Salix viminalis, osier, Europe.

Salix alba b. *cærulea,* white willow, Europe.

Salix babylonica, weeping willow, Persia, etc.

The osier is a valuable plant for our purpose, and is readily propagated by cuttings, which may be obtained from the Nelson nurserymen. The sallow and *Salix alba* may be seen in the gardens of the Auckland Acclimatization Society, but I fear the variety *cærulea* has not been introduced at present.

Populus acladesca, black Italian poplar, North America.

Populus græca, Athenian poplar, Levant.

These trees are well worthy of trial; cuttings root freely, and can be easily obtained.

Pinus pinaster var. *maritima,* pinaster, Europe.—One of the best of all known trees for our purpose, and can be obtained at all the nurseries. It has been so generally planted about Auckland and other places in the colony that seeds can be procured in large quantities. In the south of Europe the seeds form an article of food.

P. pinea, stone pine, Ravenna pine, Europe.

P. halepensis, Aleppo pine, Aleppo.—Inferior to the pinaster; the seeds of the stone pine are larger than those of the pinaster, and more highly valued for food. Both species produce seeds in the vicinity of Auckland.

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* It has been asserted that the pohutukawa will only grow on clay soils. On the South Head of the Manukau, which is a mass of blown sand, it is abundant and luxuriant, attaining a large size. Other instances might be stated.

B—Under-shrubs and Creepers.

Hymenanthera latifolia b. *tasmanica.*

Hymenanthera latifolia c. *chathamica.*

Rocky and sandy places on the coast, but remarkably local; *b.*, Spirits Bay to Onitangi Beach, rare; *c.*, Chatham Islands, compact shrubs, 2 ft. to 4 ft. high when growing on exposed sandy beaches; increased by seeds and cuttings. Young plants may be seen in the gardens of the Auckland Acclimatization Society.

Ulex europæus, L., furze, gorse, Europe.—Naturalized throughout the Colony.

U. nanus b. *gallii*, dwarf furze, British Islands.

Spartium scoparium, broom, Europe.

Naturalized in many places in New Zealand; valuable, and readily propagated by seed. I believe *Ulex gallii* would prove more effective for our object than *U. europæus*, but it has not been introduced into the Colony.

Rubus discolor, blackberry, Europe.—On sands this plant forms dense bushes, almost impervious to cattle. It is naturalized in several localities, and may be increased by seeds or cuttings.

Coprosma acerosa.—Abundant on coastal sands; seeds freely.

Opuntia vulgaris, prickly pear, South America.—Mr. Knorpp states that this plant has been successfully applied in reclaiming coast sands in Madras, but that it has become so abundant as to be a serious hindrance to travellers in certain localities. It has long been cultivated in the Province of Auckland without evincing any tendency to spontaneous propagation; it would prove serviceable in most parts of the North Island, although not in the South. Increased by cuttings, which merely require to be laid on the surface of the sand.

Olearia semidentata.—Said to form compact dwarf masses on the sandy shores of the Chatham Islands, where it is endemic.

Cassinia leptophylla, cotton-wood.—Common on sand-hills all round the coast; seeds abundantly.

Leucopogon frazeri.—Common on sands and open places; seldom more than six inches in height; stems creeping, ascending at the tips; seeds.

Vinca major, large periwinkle, Europe.—Naturalized to many places; the trailing stems take root at the tips and speedily form a close covering to the surface.

Veronica speciosa, large koromiko, Hokianga.—Grows on sand, forming a compact, luxuriant bush; easily increased by seeds or cuttings.

V. dieffenbachii, Chatham Islands.—Valuable on account of its peculiar depressed and spreading habit.

Veronica elliptica.—Of similar value to the preceding, but of taller growth.

Muhlenbeckia axillaris.—Common; seeds.

Pimelea arenaria.—Common on all sand-hills and dunes; seeds.

Agave americana, American aloe, South America.—Increases freely by suckers, and might be used in the North Island, but grows very slowly when young.

C—SUFFRUTICOSE AND SUB-HERBACEOUS PLANTS, most of which cover the surface with their foliage.

Nasturtium officinale, water-cress, Europe.—Abundantly naturalized.

Crambe maritima, sea-kale, Europe.—Seeds freely, and holds the sand by its thick roots.

Cakile maritima, sea-rocket, Europe.

Portulaca oleracea, purslane, Europe.—Naturalized; sometimes forms a matted turf in the sand, but is only of annual duration.

Lavatera arborea, sea-mallow, Europe.—A valuable plant, withstands the most violent winds, and, notwithstanding its biennial duration, seeds so freely that it is always effective; naturalized at all New Zealand ports.

Ononis arvensis, restharrow, Europe.—Seeds.

Trifolium subterraneum, subterranean trefoil, Europe.—Seeds.

Mesembryanthemum australe, fig marigold.—On all the coasts; cuttings root easily.

M. maximum, *M. falciforme*, and many other cultivated species, may be advantageously employed.

Tetragonia expansa, New Zealand spinach.—Common all round the coast.

Eryngium maritimum, sea-holly, Europe.—Seeds; a valuable plant, and much superior to the native *E. vesiculosum*.

Fœniculum vulgare, fennel, Europe.—Naturalized; seeds.

Diotis maritima, cotton-weed, Europe, North Africa.—Seeds; valuable on account of its creeping, woody root-stock and procumbent branched stems.

Tanacetum vulgare, tansey, Europe.—Cultivated in New Zealand; seeds; forms compact masses on sand.

Convolvolus sepium, bindweed.—Abundant.

C. soldanella, sea-bindweed.—Abundant on coast sands, and of great value.

Artemisia abrotanum, southern-wood, Europe.—Sparingly naturalized; cuttings and seeds.

Mentha cunninghamii.—Not rare in sands and moist places.

Atriplex cinerea.—On the coasts of both islands, but rare and local; a dwarf, branching shrub, rarely more than 3ft. in height.

Beta maritima, beet, Europe.—Cultivated.

Salsola australis, saltwort, Australia.—Naturalized on the shores of the Waitemata.

Polygonum rayi, Ray's knotgrass, Britain.—Seeds; grows close to the surface, which it speedily covers.

Euphorbia glauca, sea-spurge.—Common all round the coasts; a most valuable plant for binding the surface, often growing in places exposed to the wash of the sea.

E. portlandica, Portland spurge, Europe.

E. paralias, Europe.

The above are in no way superior to the native species.

E. peplis, sun-spurge, Europe.—This has been recommended by some writers, but, from its annual duration, is of little value. I consider it inferior to the purslane, which is abundantly naturalized.

Iris susiana, Chalcedonian iris, Levant.

I. germanica, Germany.

Seeds and divisions of the root; naturalized in many parts of the Colony, especially abundant at the Bay of Islands; plants of great value from their abundant, fleshy rhizomes and rigid leaves.

Asparagus officinalis, asparagus, Europe.—Seeds; cultivated in New Zealand, holds the sand by its matted roots.

Arthropodium cirrhatum, rengarenga.—Common on the coasts of the Auckland Province.

Cyperus ustulatus, prickly toe-toe.—Abundant throughout the Colony, and of great value.

Arundo conspicua, toi-toi.—Abundant throughout the Colony; seeds; one of the most valuable plants available for coastal reclamation.

Asplenium lucidum, wharengarara.—Abundant, especially near the sea; forms large clumps on the sands in the southern part of the Colony.

D—Sedges and Grasses, chiefly with creeping roots.

Desmoschœnus spiralis, pingao.—Common on blown sand all round the coast; seeds freely.

Carex pumila.—Common on loose sandy shores.

C. raoulii.—Not uncommon.

C. inversa.—Rare and local.

C. arenaria, sand-sedge, Europe.

Seeds are produced freely, and all the species may be increased by cuttings of the creeping rhizomes, or, in the case of *C. raoulii*, by division of the root. *C. arenaria* is more valuable than either of the native species.

Spinifex hirsutus.—On all loose maritime sands the long trailing stems are often 20ft. long, or more, and will root at every joint if fastened down; like the pingao this will only flourish in loose sand.

Paspalum distichum.—Common on beach margins in the North Island, and about Nelson; forms a compact sward in rather moist situations.

Zoysia pungens.—Abundant on sandy and muddy beaches, etc., etc.; forms a dense matted turf; greedily eaten by sheep and horses.

Dichelachne stipoides.—On sands north of the Hauraki Gulf; a fine wiry grass of tussocky habit.

Sporobolus elongatus, rat's-tail grass, chilian grass.—Abundant in the North Island and Nelson; a strong, coarse grass capable of adapting itself to a great variety of soil and exposure; eaten by cattle.

Psamma arenaria, marrem, Europe.—Cultivated in New Zealand; extensively used in Europe for binding sands.*

Cynodon dactylon, doab grass, India.—Naturalized throughout the Colony; of great value.

Holcus mollis, soft fescue, Europe.—Naturalized throughout the Colony; valuable on account of its creeping roots; endures the sea-spray; herbage of little value.

Aira canescens, Europe.

Glyceria loliacea, Europe.

Poa breviglumis.—Common on sands, etc., especially in the South Island; a grass of great value.

P. australis var. *lævis.*—Common from Port Waikato southwards; resembles *Dichelachne stipoides* in habit, but is more diffuse.

P. bulbosa, Europe.

Festuca littoralis.—Common on sands in both islands; of great value.

Triticum repens, couch grass, Europe.

T. junceum, Europe.

Creeping rooted grasses of great hardiness, but producing herbage of little value.

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* In the course of a recent hasty walk on the beach between the town of New Plymouth and the Sugar Loaves, during the stay of a passing steamer, I had pleasure in observing dead culms of an exotic grass apparently belonging to this species, and which exhibited great luxuriance, being 4ft. to 5ft. in height. I was unable to ascertain if it occurred in other localities in the district, or to procure any particulars respecting its introduction; but, from its being found in several patches of considerable extent and in many widely-scattered and isolated tussocks, it would appear that seeds were scattered on the beach without protection. It is much to be desired that any person acquainted with the circumstances under which the plant was introduced would place a statement thereof on permanent record, with particulars as to date and present extent of diffusion, as precisely as can be ascertained.

A considerable quantity of seed could be collected without difficulty, and, in some cases, offsets might be taken off, so that with comparatively little expense a portion of the beach might soon be fixed. Offsets must, in all cases, be taken off sparingly, so as to disturb as little of the fixed surface as possible.

Lepturus incurvatus, Europe.—Abundantly naturalized on sands in the Auckland Province, but of trivial value.

Elymus geniculatus, lyme grass, Europe.—Of equal value with the marrem.

Stenotaphrum glabrum, buffalo grass.—Increased by seed and cuttings, etc. ; of stout procumbent habit, and producing a large yield of nutritious herbage.

It would ultimately prove advantageous to the Colony if a small portion of the money now being spent on public works could be applied to the reclamation of sand wastes. The magnitude of the evil to be remedied is admitted by all who have paid the slightest attention to the subject. In several localities the natives are compelled, year by year, to abandon their cultivations as the sand-wave advances, and settlers are helpless witnesses of the destruction of their paddocks from the same cause. Fences, large trees, and patches of bush, have been overwhelmed within the memory of settlers of comparatively recent standing, and, in some cases, still more serious injury must result unless preventive measures are taken. The danger is not confined to any one district or province ; it is general, and demands prompt attention.

While much can be done with the means already at command, there can be little doubt that other plants, both indigenous and exotic, would prove available on actual experiment, and some species may be found to possess greater value than many of those at present known.

The work of reclamation in this Colony is greatly facilitated by the favourable nature of the climate, which allows the employment of many plants not available for the purpose in other countries.

It must be confessed that such localities as the Waikato Heads, and some parts of the Kaipara sand-hills, are calculated to produce an impression of man's inability to cope with nature ; but, if we look at what has been accomplished with more slender resources than those now indicated, it will be seen there is abundance of encouragement. In the Gulf of Gascony immense wastes of trackless sand were utterly destitute of vegetation, and during violent storms exhibited a complete change of surface, hills becoming valleys and valleys taking the place of hills, the sand being gradually carried into the interior, and covering cultivated fields, villages, and entire forests. This process of devastation has been completely arrested, and thousands of acres of former sand-waste now yield a handsome revenue, and support a considerable population. To arrest the process of destruction now to be seen in so many localities in this Colony is an object for which we may well venture to encounter the possibility, the probability even, of repeated failures in the certainty of ultimate success.

Art. X.—*Notes on Indigenous Materials for the Manufacture of Paper.* By T. Kirk, F.L.S.

[*Read before the Auckland Institute, 8th December,* 1873.]

Doubts having been freely expressed as to whether the Colony possesses a sufficient abundance of raw material for the manufacture of paper to allow of the process being undertaken on a remunerative scale, it may be worth while to call attention to several plants available for the purpose, all of which occur in abundance, and are being yearly destroyed to an enormous extent by the progress of settlement. Several of them could be cultivated so as to afford a regular supply.

Kahakaha, *Astelia solandri.*—The tree-flax of the settlers; abundant on lofty trees and rocks throughout the Colony; the entire leaf produces a considerable quantity of fibre, and is thickly clothed at the base with silky, shaggy, lustrous hairs; it is usually found on rocks from sea-level to 2,500ft. or 3,000ft., and on the limbs of trees, where, at a distance, it resembles the nest of some huge bird. The leaves are radical, 1ft. to 2ft. long, and produced in large numbers. Hundreds of tons are destroyed on every acre of forest land cleared in the North Island.

Kowharawhara, *Astelia banksii* and *A. cunninghamii*, have the habit of the preceding species, but the leaves, although narrower than that plant, are from 3ft. to 6ft. in length, and produce a superior fibre. *A. cunninghamii* is common on trees and rocks, and *A. banksii* is found in immense profusion in wooded places by the sea; both occur in abundance in the North Island, but their southern distribution is uncertain.

Kauri-grass, *Astelia trinervia.*—Perhaps the most abundant of all the species, occasionally forming the chief part of the undergrowth in the northern forests up to 3,000ft., and so dense that it is often difficult to force one's way amongst the interlaced leaves, which are from 3ft. to 8ft. long, and of a paler green tinge than either of the preceding. It could be procured by hundreds of tons, and as, like the other species, it is found in situations not adapted for ordinary cultivated crops, a permanent supply might be fairly calculated upon. Experience has shown that it may be cut yearly.

The leaves of all the species of *Astelia* are clothed at their base with silky shaggy hairs, and the entire surface is covered with a thin pellicle.

Ti, or cabbage-tree, *Cordyline australis.*—A shrub or small tree, from 6ft. to 25ft. high, found throughout the Colony, often in immense abundance—as in the Bay of Islands and Waikato districts. This plant is too well known to need description; it is sufficient to state that it produces a large quantity of fibrous material, and might be readily cultivated. An obscure plant closely

allied to this is cultivated for food by the natives of the Upper Wanganui district.

Some years ago leaves of this plant were sent to England and manufactured into paper at one of the Yorkshire mills. The article was highly commended in a trade periodical, and the propriety of importing a constant supply of the raw material steadily advocated. I greatly regret that I have mislaid my reference to the trade circular in which the notice appeared.

Ti ngaherehere, *Cordyline banksii.*—A much smaller plant than the last, producing fibre of a superior quality, but in smaller quantity. It is abundant on the margin of forests, gullies, etc., throughout the North Island and northern parts of the South Island, and, like the preceding species, could be readily cultivated.

Cutting grasses, *Gahnia setifolia* and *Gahnia ebenocarpa*, appear well adapted for the manufacture of coarse papers. The former is abundant in both islands, and could be procured in almost unlimited quantity ; the latter is rather local in its distribution, but the tussocks individually afford a larger quantity of leaves, which are often 8ft. in length.

Other sedges and grasses might also be utilized, especially the curious sand-grass, *Spinifex hirsutus*, and the sand-fescue grass, *Festuca littoralis*. The last might possibly form a substitute for Esparto. The curious sedge called the pingao, growing on shifting sands, might prove to be valuable ; also, the tawera, or New Zealand screw pine, *Freycinetia banksii*, which is abundant in moist woods, often climbing to the tops of the loftiest trees, and might be procured by thousands of tons. The nikau also appears to offer material suitable for the manufacture of coarse wrapping papers, etc.

I have not mentioned *Phormium*, since its merits are so well recognized that a company has been formed in Auckland specially for the utilization of its fibre in paper manufacture.

The various species of *Celmisia*, chiefly known by the settlers as cotton-grass or leather-plant, appear well adapted for our purpose. They are comparatively rare in the North Island, the most common being *C. longifolia*, which is abundant on the central plains but does not attain a large size ; to the north of Auckland it only occurs in isolated localities. In the South Island the genus is plentiful, numerous fine species with large leathery leaves, more or less hairy or woolly, being abundant. I have specimens of *C. verbascifolia* in my possession, in which the leaves are nearly 2ft. long. *C. coriacea*, a much commoner species, is perhaps still more valuable.

Although strictly outside the limits of this paper, it may not be amiss to state that at several English mills wheaten straw has, for many years past, been manufactured into paper of good quality, and which has come into general use. At present wheaten straw is of little value in the Colony, so that a

considerable amount of raw material could be obtained at small cost, to the joint benefit of the agriculturist and the manufacturer. Wrapping paper has long been manufactured by the Americans from the flowering sheaths of maize, but this material could scarcely be obtained here in sufficient quantity to be made available by the manufacturer.

ART. XI.—*On the Prediction of Occultations of Stars by the Moon.* By T. HEALE.

[*Read before the Auckland Institute, 10th November,* 1873.]

ALL the methods in use for ascertaining the longitude, independently of chronometers, depend upon the observation of the moon's position at a certain instant of time at the place, then ascertaining from the tables of the moon in the nautical almanac, or other similar publications, the instant of time at Greenwich, or other standard position, at which she reaches that point. The difference between the two times so obtained is the difference of longitude between the two places.

The most complete, as well as the most simple, method of making this comparison, and the one almost invariably used for observatory purposes, is to note the exact time of the moon's crossing the meridian of the place by the transit instrument, taking, at the same time, her zenith distance, or not, according to the instrument employed.

But to effect this in at all a satisfactory measure requires an observatory and fixed instruments of an expensive character, and accurate observations kept up for a considerable period and elaborately reduced by computation. It is, therefore, inapplicable to the purposes of a traveller, either by sea or land. The method chiefly employed when an approximate result has to be obtained from a single set of observations, is by observing the moon's angular distance from the sun, a planet, or a fixed star, commonly called lunars.

The chief objections to this method depend on the circumstance that since the moon at fastest moves only about 1 second to 24 seconds of longitude, and ordinarily much less, every second of error in the angular measurement produces an error about thirty times as great in the longitude; and as the observations have often to be taken in very inconvenient postures, in which only light instruments held in the hand are available. On board ship accuracy cannot, as a rule, be expected from them, and in practice they are now but little used—far less frequently, as far as my observation goes, than they used to be forty years ago, though the trouble of computing them has been greatly lightened by special tables.

The only remaining method of importance is by occultations of fixed stars,

by which a very accurate determination of longitude may be had from a single observation, for which no instrument is necessary but a hand telescope of moderate power.

This excellent method was scarcely available for travellers before binocular telescopes came into use, but they seem to me now to be very unduly neglected, especially by seamen. The causes of this neglect are not far to seek. The first is an irreparable one: they occur very rarely—there are not, on an average, more than twelve each month for each latitude, of which seldom one-half are fairly available for good observation on shore—and with the small-power telescopes, which it would be necessary to use on board ship, the really available cases would hardly occur oftener than two in a month. But another cause of the unpopularity of these observations is, that it is necessary to make a preliminary investigation for each star that seems likely to be available, the result of which, when made, very often is simply to show that it is useless; so that out of half-a-dozen stars predicted it is rarely that more than one proves altogether suitable, and even that one may be lost by a passing cloud.

It must be confessed that this is a discouraging circumstance at the best, and when the prediction required an elaborate calculation, involving the solution of three spherical, and at least two plane, triangles, it was fatal to its use by practical men. I shall proceed, however, to show that the trouble may be reduced to very small dimensions indeed.

The elements necessary for the prediction and computation of occultation are given in the nautical almanac, and more copious ones in the American nautical almanac; but they could only be given without great labour for *belts* of latitude, and a special investigation has to be made for each place. Various plans have from time to time been published for abridging the labour of these predictions. The first I am acquainted with is a pamphlet by Captain, now Admiral, Shadwell, which was published by the Admiralty in 1847. The principle on which it is based, is to use essentially the same processes as those required for the final computations, but to shorten them by using approximations instead of the accurate elements; by treating all the triangles as plane, and solving them by the use of the traverse-table, with which seamen are very familiar.

But the most practically useful method of approximate prediction is by the method of graphical projection. Drawing a diagram of the earth as it would appear to an eye situated in the star at the moment of conjunction in right ascension, showing the line on it upon which the spectator would be carried in given intervals of time by the earth's motion, then marking a point on the picture at which the moon's centre would be at the same moment, and a line to indicate the direction of her movement, with the points on it which she will reach in given intervals; then it is clear that if the figure of the

moon covers any point on the earth at the time the spectator is there, the star will not be visible to him, or it will be occulted, and it is obvious that the moment when the moon's image on the drawing just touches the part where the spectator is at the moment, on either side, will be the time at which the disappearance or occultation and egress will occur.

To construct such a diagram as this does not require any considerable calculations, but it is tedious, and, in practice, a pretty expert computer and draftsman would hardly compute it in less than an hour, which is a good deal of labour to expend on a mere preliminary, which may have to be many times repeated before one is come to which proves to be available for observation. A rather large book by Mr. F. C. Penrose, containing an elaborate method of shortening the labour of this graphical process, was published in England three or four years ago. In it there are diagrams ready made, upon which the elements of an occultation, as taken from the nautical almanac, may be laid down, the reduction necessary being made by means of a slide rule. I hardly think that this method will be much used. It is possible that I may be so wedded to methods to which I am accustomed that I do not readily take to other ones; but, to me, it appears quite as troublesome as the ordinary plan as given in Loomis and many other astronomical books, to which, after giving every attention to Mr Penrose's method, I have found it most convenient to adhere; but, in practice, I have adopted some mechanical aids which, without in any degree altering or modifying the plan, assist so largely in carrying it out that I now find that by their use I can predict at least four in the time it used to take me to project one, and without any sensible diminution in accuracy, the result being, that when an occultation occurs while the moon is within an hour or two of the meridian, the prediction is true within a limit of about two minutes, the possible error increasing to about double that quantity when the moon is four hours from the meridian.

In laying down a diagram by any process it is necessary to lay down in their true relative values the magnitude of the earth, or, at least, of the ellipse into which the observer's latitude-parallel is projected; of the different hour spaces upon it; and of the moon and her position and motions. The ready way of doing this is either to take the moon's horizontal parallax in seconds, and to adopt that on a suitable scale as the earth's radius, in which case the values of the hour intervals and of the observer's distance from where the star is vertical must all be reduced to that radius; or an arbitrary radius, as 1,000, may be used, and the value of the hour intervals in the observer's latitude may then be laid off one for all, the same diagrams being used for an indefinite number of predictions; but then all the other quantities must be reduced to that radius, and in either case the ellipses into which the observer's latitude-parallel is projected must be set out for each occultation or eclipse predicted,

and the values of the hour-spaces marked on it, and this is the most troublesome part of the operation. Penrose's method gives several ellipses already drawn, from which one may be selected which corresponds most nearly with the circumstances of the eclipse to be predicted.

Now the method I employ is the first and simplest one. I take out roughly, by inspection, the moon's horizontal parallax at conjunction, and adopt that as a radius; the position of the observer and of his antipodes are then got out by taking the sum and difference of the declination and the sine of the observer's latitude into the adopted radius. These can then be laid off by scale on a vertical line drawn on any sheet of paper from a fixed point at its upper end, through which a line is drawn perpendicular to it. The moon's place at conjunction can then be marked on the same line by scaling off the distance south in seconds, as given in the nautical almanac, and the moon's hourly motion in right ascension, reduced to an arc of a great circle, is measured on the horizontal line on top, and her motion north or south on the perpendicular line. A line parallel to the diagonal of those co-ordinates drawn through the moon's place at conjunction will give her course, and the distance she travels in parts of an hour may be marked off on it, the times of which should be marked on them. All this is just as would have to be done on the ordinary method, but then, instead of constructing the ellipses representing the parallels of latitude and computing the hour divisions, I keep a set of ellipses, cut out of cardboard, for every 30″ of horizontal parallax, and for every 100″ of semi-minor axis, on which the hour divisions are permanently marked. I see at a glance which ellipse suits the conditions best—that is, the one drawn to the same horizontal parallax, and of which the minor axis corresponds with the distance in seconds of the observer and his antipodes—and at once rule in the curve from the card, and also mark the hour divisions from it. I have then only to take off the moon's semi-diameter, which, bearing a fixed proportion to the horizontal parallax, may be marked off on each cardboard ellipse, and it is the work of a minute to see the moment at which the ingress and egress occurs, and the point on the moon's perimeter at which the star enters and emerges. It is obvious that the same process is equally applicable to solar eclipses, taking of course the differences of their parallaxes and motions and the sum of their semi-diameters.

Now that binocular telescopes are so largely used, and are made to powers so considerable as 7 or 8 diameters, the observation of a star of fourth magnitude entering on the dark limb of the moon—that is before the full—may be perfectly well observed on board ships, and, I believe, in clear weather fifth magnitude stars could be seen; and, as one observation will give a longitude thoroughly trustworthy within very narrow limits, it seems a pity that they should so seldom be used.

I have here the computations of five occultations which I have observed with a portable telescope at different times without any special care. Of these four agree with one another within a maximum of seven seconds; the fifth is apparently affected by some blunder, as it varies upwards of twenty seconds from the others, but, as even this discrepancy is only about four and a-half statute miles, it might be considered accurate in comparison with the approximations generally available on board ship.

The calculation of longitude from the observations is, it will be observed, not by any means formidable for its length, and it presents no intricacies which an ordinary navigator may not easily master.

II.—ZOOLOGY.

ART. XII.—*On* Harpagornis, *an Extinct Genus of Gigantic Raptorial Birds of New Zealand.*

By JULIUS HAAST, Ph.D., F.R.S., Director of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 4th June, and 2nd July,* 1873.]

Plates VII., VIII., IX.

(ABSTRACT.)*

IN a paper read before the Philosophical Institute of Canterbury, in 1871,† I offered the first account of the discovery of a few bones belonging to a gigantic bird of prey, which were obtained with a considerable quantity of Moa bones in the turbary deposits of Glenmark, a locality which will ever be celebrated in the scientific annals of New Zealand as the spot which, doubtless, has furnished the largest quantity and variety of bones available for the elucidation of the anatomy of the wonderful, wingless, struthious birds of this country.

The bones described in that paper consisted of a left femur, two ungual phalanges, and a rib, all belonging to the same specimen.

Since the publication of those first notes, further excavations were undertaken in the same locality; and in following down the swampy water-course from which these few remains of *Harpagornis* were previously obtained a further series of bones was discovered, which, on examination, proved to be another portion of the same skeleton described in that first memoir.

The bones recently obtained were scattered over the bottom of the turbary deposit along the old water-course, 6ft. to 7ft. below the surface, amongst the remains of decaying swampy vegetation. They were mixed up with pieces of drift timber, and with a considerable number of Moa bones, several of them belonging to the larger species (*Din. giganteus* var. *maximus*, and *Din. robustus*).

The bones obtained during these latter excavations consisted of the following :—right and left metatarsus, right and left tibia, right and left fibula, right and left ulna, right and left radius (one fragmentary), right and left scapula, one rib, five phalanges, four ungual phalanges.

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* At the request of the author, the publication of this paper at full length has been deferred until all the illustrations can be published of natural size, in quarto form. —ED.

† Trans. N.Z. Inst., Vol. IV., p. 192.

Our search after the pelvis, sternum, and cranium, was in vain, so that I shall not be able to offer a description of these important parts of the Glenmark skeleton; but, as will be seen in the sequel, I can at least do so as far as the pelvis of the species is concerned, Dr. Hector having kindly handed over to me, for such purpose, a well-preserved specimen of that compound bone, found in one of the Otago caves.*

This list does also not contain any humerus, but we possess at least a fragmentary one, without doubt belonging to this species, which was obtained about a mile above Glenmark, from the banks of the Glenmark Creek. These banks rise in some places about 100ft. above the water-line, in nearly perpendicular cliffs, and consist of postpliocene alluvium, formed by large beds of shingle, with which smaller deposits of sand and turbary deposits are interstratified.

We obtained also the lower portion of a metatarsus, from a similar older postpliocene bed situated close to Glenmark, so that there is sufficient evidence to show that this diurnal raptorial bird existed, like the *Dinornis* and *Palapteryx* species, during a long period in New Zealand.

Some time after having made the discovery of the further portion of the skeleton of *Harpagornis moorei*, in continuing our excavations on the Glenmark property, on the left bank of the Glenmark Creek, and opposite the spot previously alluded to, we obtained, amongst a considerable quantity of Moa bones, a large portion of another skeleton of a raptorial bird, which, although of smaller size than the first-named species, is still of remarkable dimensions. These bones were found not far apart, and near the bottom of the swamp, close to a layer of clay, 7ft. to 8ft. below the surface.

This new find consisted of the following bones: pelvis (fragmentary), right and left metatarsus, right and left tibia, right and left femur, right humerus, right and left ulna, left metacarpal, left scapula, one rib, four phalanges, one ungual phalanx.

In comparing these with the bones of *Harpagornis moorei*, it became at once evident that they belonged either to a closely allied form, or, making allowance for sex, to the former species.

The disproportion in size of our recent diurnal raptorial birds is so great, that even at the present time the question as to the existence of one or two species of *Hieracidea* is not yet definitely settled. This remarkable difference in size is also observable in the New Zealand Harrier, where the female is

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* This is one of the bones referred to in Trans. N.Z. Inst., Vol. IV., p. 114 (footnote), as having been forwarded by Mr. W. A. Low, which were found in the surface soil under an overhanging rock, and not in a proper cave. This particular bone is in wonderful preservation, and is still covered with periosteum and has the capsular and some other ligaments adherent, while the osseous substance has lost hardly any of the original animal matter which it contained.—J. HECTOR.

generally much larger than the male bird. Moreover, when comparing the male and female skeletons of *Circus* with each other, there are some slight sexual differences easily discernible, which might suggest that they belonged to two nearly allied species, did we not know their real relations to each other.

As I shall show further on, the bones of both specimens of *Harpagornis* belong to adult birds, of which the largest died at a more mature age than the smaller one. Thus the smaller specimen might possibly be the male of *H. moorei*, assuming the latter to be the female. However, as I am not able to settle this point at present, I shall propose for the second and smaller specimen the specific name of *H. assimilis*, in order to point out the close relationship of both.

Dr. Hector suggested* to me that the *Harpagornis* might possibly be the Hokioi of the Maoris, which, however, according to Buller, is the Great Frigate Bird *(Fregata aquila)*, obtained repeatedly in New Zealand, and of which he gives several instances in his work on the birds of New Zealand.†

What the large bird of prey is that I have met several times during my explorations amongst the snow-clad ranges constituting the Southern Alps, without being able to secure a specimen, is a question which I hope future and more fortunate explorers of those regions will one day solve.

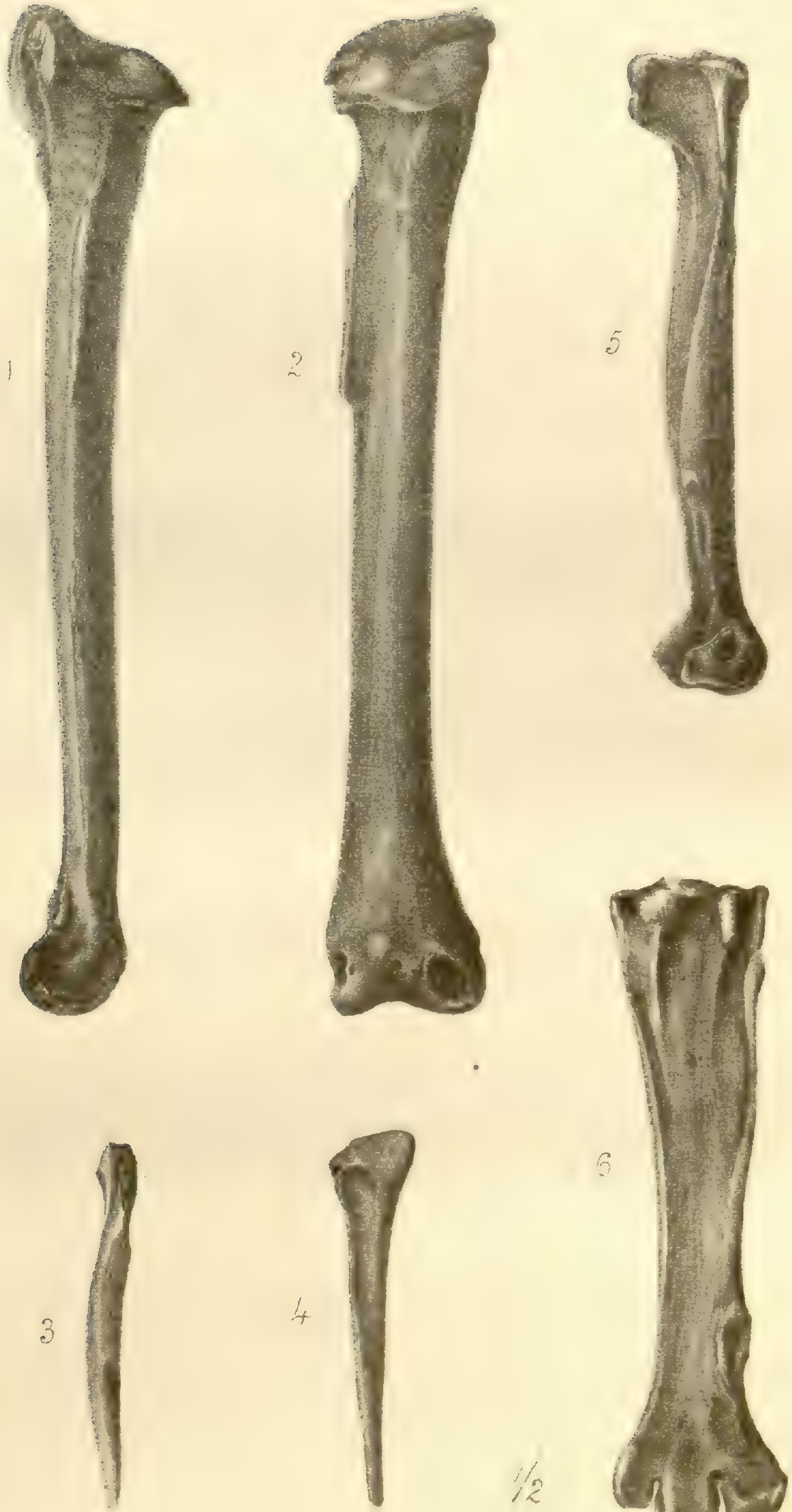
Before offering a description of the extremities of *Harpagornis*, I wish to draw attention to the following table of measurements, in which I have placed in juxtaposition the length of the principal leg and wing bones of all the diurnal birds of prey of which I had material for comparison.

TABLE OF MEASUREMENTS.

	Harpagornis moorei.	*Harpagornis assimilis.*	*Aquila audax*, Australia.	*Circus assimilis*, New Zealand.	*Hieracidea novæ zealandiæ*, New Zealand.
	Inches.	Inches.	Inches.	Inches.	Inches.
Metatarsus - -	6·08	5·87	4·63	3·47	2·25
Tibia - - -	9·52	8·92	7·04	4·26	2·91
Femur - - -	6·66	6·09	4·90	2·79	2·22
	22·26	20·88	16·57	10·52	7·38
Humerus - -	—	8·57	8·20	4·06	2·35
Ulna - - -	10·36	9·35	9·38	4·81	2·65
Metacarpus - -	—	4·48	4·45	2·47	1·61
		22·40	22·03	11·34	6·61

In comparing, in the first instance, the length of the femur with the

* On the authority of Sir George Grey. Trans. N.Z. Inst., Vol. V., p. 435.—ED.
† Buller's "Birds of New Zealand." 4to., 1873. P. 340.—ED.



J.B. del. et lith.

HARPAGORNIS MOOREI.

metatarsus, it will be seen that in *Harpagornis* the former is longer than the latter limb bone, in this respect resembling *Aquila*, whereas in *Circus* the opposite is the case, the metatarsus being longer than the femur. This, to a minor extent, we observe also in *Hieracidea*. However, when we take the united length of the three principal leg bones into consideration, and compare them with the three principal wing bones, the result is quite different.

Thus, whilst the wing bones of *H. assimilis* are only 1·52 inches longer than the leg bones (20·88 inches to 22·40 inches) in *Aquila*, they are, notwithstanding their smaller dimensions, 5·28 inches longer (16·57 inches to 22.03 inches); *Harpagornis* here again agreeing more with *Circus* (10·52 inches to 11·34 inches).

According to their different proportions, the wing bones of *H. assimilis*, when compared with *Aquila audax*, ought to be 27·53 inches, instead of 22·40 inches their actual size; and, with *Circus*, 22·50 inches, a result which closely agrees with the above measurement. Of *H. moorei* we possess only the ulna, the length of which, 10·06 inches, compared with the same bone in the smaller *H. assimilis*, 9·35 inches, would give for the whole wing bones a total length of 24·10 inches, instead of 29·62 inches, as calculated according to the measurements of *Aquila audax*.

I wish also to point out that in *Hieracidea* the united length of the wing bones is actually less than that of the leg bones (7·38 inches to 6·61 inches), although this little bird is remarkably strong on the wing.

Femur.

Harpagornis moorei. Trans., Vol. IV., Pl. X., Fig. 1.

In my former notes on *Harpagornis* I offered a short description of the femur (vol. iv., p. 193), comparing it at the same time with the corresponding limb bone in the skeleton of *Palioaëtes leucogaster*, the white-bellied Sea-Eagle of Australia, and of *Circus assimilis*, the New Zealand Harrier; but I shall, in the following notes, compare all the principal bones of *Aquila audax*, the largest Australian species of Diurnal *Raptores*, with those of the extinct New Zealand bird.

Harpagornis assimilis.

	Inches.
Total length of femur	6·09
Circumference of proximal extremity	4·10
Circumference of distal extremity	4·83
Circumference of shaft where thinnest	2·22

This bone, besides being of smaller dimensions, is somewhat slighter in its form, otherwise the description as given of that of *Harpagornis moorei* closely corresponds in all its principal points. There is no doubt, judging from the insertion marks of the muscles and the intermuscular linear ridges, that this

species was also very powerful. Of the latter the linea aspera is not quite continuous, being repeatedly interrupted at more or less considerable intervals. The form of the proximal orifice is somewhat different from that of *H. moorei*, it being more rounded; however, this may be a sexual or even individual peculiarity, and of no specific value.

Examining the femora of a male and a female *Circus*, I observe that this proximal orifice in the larger female is also oval, and in the smaller male more rounded off.

I have already alluded to the probability that the portions of the two skeletons of extinct birds under consideration might belong to the male and female of the same species, owing to a resemblance in their principal osteological features and to the great disparity of size of many of the recent Diurnal *Raptores.*

In order to illustrate this more fully, I would suggest a comparison of the femora of *Circus assimilis* of both sexes, both belonging to full-grown and mature birds, obtained under similar conditions.

Certainly, if these two bones had been found in a fossil state, one would not deem it expedient to place them in the same species, owing to their remarkable difference in size.

Tibia.

Harpagornis moorei. Pl. VII., Figs. 1 and 2.

	Inches.
Total length	9·52
Circumference at proximal end	5·48
Circumference at distal end	4·60
Circumference of shaft where thinnest	2·22

The same pachydermal character, if I may thus express myself, distinguishes also this bone, like all those of the posterior limb of this gigantic species, from any bird of prey known to inhabit New Zealand at present.

Even in comparing the same with that of *Aquila audax*, of Australia, with which it has otherwise many features in common, this character is well exhibited.

The form of the surface of the proximal end agrees well in both species, with the exception that the proximal ridge is more rounded off, and the intercondylar tuberosity stands higher in *Harpagornis*, in which two features the fossil bone agrees more with *Circus.*

Two narrow and low intermuscular ridges are well marked, the first of which begins at the base of the procnemial process and extends to the inner side of the extensor tendinal canal, above the bony bridge spanning over the precondylar groove; the other at the termination of the vertical fibular ridge, descending the shaft in a transverse line till it has crossed two-thirds of its

breadth, within one inch above the bridge, then retreating again with a gentle curve. After forming the outer boundary of the groove, it then terminates on the outer side of the canal for the extensor tendon ; thus differing from *Aquila*, where this second ridge reaches only to the middle of the shaft, and does not describe such a considerable arc as we observe upon the fossil bone.

The distal condyles are well curved at their anterior ends, and have a more rounded form (which the outer condyle shows most conspicuously) than either *Aquila* or *Circus*, in which they are more oblong. Moreover, those of the recent species stand more in advance of the shaft.

The inner distal condyle is also more developed in a transverse extent than the outer one—a feature also exhibited by *Aquila*.

The shaft of the bone, although slightly bent backwards near its proximal end, is, however, straighter than in *Aquila*, but not so straight as that of *Circus*. The fibular ridge is strongly developed.

Harpagornis assimilis.

	Inches.
Total length	8·92
Circumference at its proximal end ...	(partly broken away).
Circumference at its distal end	3·80
Circumference of shaft where thinnest	1·91

This tibia, although possessing all the main characteristics of the larger species, is, when considering its total length, of a somewhat slighter form. I observe, however, that the distal condyles are more oblong, agreeing more in their shape with the recent species hitherto used for comparison. This is best seen in the outer condyle.

Might this peculiarity not be traced to age, the skeleton of *Harpagornis moorei* doubtless having belonged to a more aged bird than the smaller species? Thus the texture of the extremities of the tibia of the former is far more compact than in the latter, in which, although well anchylosed, a want of solidity is observable.

FIBULA. Pl. VII., Figs. 3 and 4.

Amongst the smaller bones obtained from the locality where the principal portion of the skeleton of *Harpagornis moorei* was excavated are a pair of fibulæ, which, on closer examination, proved to belong to that skeleton. Of these the right one is the most perfect. It is 4·27 inches long, the distal point being broken off.

The articular head, 0·80 inch long and 0·31 inch broad, is very large and posteriorly slightly convex, its anterior edge sloping down at a considerable angle, far more than in *Aquila* or *Circus*, in which the articulating surface is nearly plane, and stands at a right angle to the shaft. The head is also far more hollowed out on the inner side than *Aquila*.

The shaft in its upper portion is considerably bent backwards, and very broad where it is attached to the tibia, after which it decreases rapidly in size. Two shallow pits for the insertion of tendons are well marked.

Metatarsus.

Harpagornis moorei. Pl. VII., Figs. 5 and 6.

The following are the measurements of this important bone :—

	Inches.
Total length	6·08
Circumference at its proximal end, the calcaneal ridges included	4·09
Circumference at its distal end	4·28
Circumference of shaft where thinnest	1·90

In its general form also, this bone resembles in its main features that of *Aquila*, except being somewhat more robust.

The shaft at its upper end is expanded and transversely flat, gradually becoming narrower, and assuming towards its middle a trihedral shape, after which it flattens again above the fore and aft canal, between the middle and outer metatarsal, near their distal ends.

In *Circus* the trihedral portion of the bone is much longer, even in comparison to its whole length, than either in the fossil bone or in *Aquila*.

The form and position of the trochlear condyles agree more closely with *Circus*, they being broader and with a larger space between them than in *Aquila*.

The tuberosity for the insertion of tibialis anticus is remarkably developed, another proof of the great power the fossil bird must have possessed.

The ectocondylar concavity is well marked, far more than in the recent species, in both of which the outer side of the proximal surface is almost plane.

The three tendinal grooves between the calcaneal processes and the inner posterior ridge are deeply excavated, much more than in *Aquila audax*. Half-way down the shaft they unite to form one concave channel, which, above and close to the process for the attachment of the metatarsal of the back toe, runs out to a flat surface.

The two fore and aft foramina in the upper part of the bone, in the grooves near the base of the anterior intercondylar prominences, are well marked.

The surface of the bone running from the outer margin of the ectocondylar ridge down to the outer condyle is very broad and flat, as in *Aquila*, having its greatest diameter in the middle portion of the bone, thus forming the base of its trihedral form.

In *Circus* the base of the bone is situated more in its posterior portion, the ridge running towards the centre of the anterior portion of the shaft, giving the latter a triangular form for about two-thirds of its entire length.

HARPAGORNIS MOOREI.

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Harpagornis assimilis.

	Inches.
Total length	5·87
Circumference at its proximal end, ridges included ...	3·78
Circumference at its distal end	4·02
Circumference of shaft where thinnest	1·78

The shaft of this bone, if we compare its total length with that of *H. moorei*, is generally narrower ; this is most conspicuous above the deeply excavated process for the attachment of the back-toe metatarsal, where the shaft is thinnest.

The ectocondylar ridge is also more pronounced, by which the shaft assumes a more triangular form than it possesses in the larger species. The two posterior ridges on both sides of the concave channel are more sharply defined, so that the latter is deeper than in *H. moorei*, approaching in form more that of the Australian Eagle.

HUMERUS.

Harpagornis moorei.

I already observed, in the preliminary remarks, that our search in the turbary deposits of Glenmark after the humerus of this species had been unsuccessful, but that we obtained a fragment of that bone from the postpliocene alluvium on the banks of the Glenmark Creek, about one mile above Glenmark. This fragment consists of the greater portion of the shaft, the proximal and distal extremities being broken off.

The shaft where thinnest has a circumference of 2·20 inches, or 0·15 inch more than the same bone of *Harpagornis assimilis*, of which we possess a perfect specimen.

It doubtless belonged to an adult bird, and, if restored, would be about an inch longer than the smaller species.

Harpagornis assimilis. Pl. VIII., Figs. 1 and 2.

	Inches.
Total length	8·57
Circumference of proximal end	4·49
Circumference of distal end	4·10
Circumference of shaft where thinnest	2·05

This important bone, with the exception of a small portion of the radial crest, is quite perfect. In its general outlines it has, like the other portions of the skeleton, great affinities both to *Aquila* and *Circus*.

The shaft is not so straight as that of *Aquila*, having below the lower termination of the radial crest an outward bend, which is also well exhibited in *Circus*. At the same time, the proximal extremity is more curved towards the ulnar side in the fossil bone.

The shaft at one-third of its total length above its distal end is nearly round in a transverse section, a feature it has in common with *Circus*, whereas the shaft of *Aquila* is more subelliptic.

The articular head forms a more distinct tuberosity than in *Aquila*, which is also observable in *Circus*; a broad groove dividing it from the ulnar crest, which advances considerably over the pneumatic foramen.

The radical crest being partly broken off, its whole extent cannot be ascertained. The ridge forming the boundary of the large depression for the insertion of the pectoralis major is well marked.

The articular convexities of the distal extremity are also of considerable size, and well carved out; the pits for the attachment of the muscles are large and deep, all tending to prove that *Harpagornis* possessed considerable power of flight.

Ulna.

Harpagornis moorei.

This bone has the following dimensions:—

	Inches.
Total length	10·06
Circumference at its proximal end	3·15
Circumference at its distal end	2·52
Circumference of shaft where thinnest	1·77

In comparing its total length with the corresponding bone in *Aquila audax*, as given in the table of measurements, it will be seen that it is only 0·68 inch longer, but that it is distinguished from it by its considerable thickness and the greater expansion of both articular ends. This is most conspicuous when examining the proximal surface, but, considering the great breadth of the distal end of the humerus, quite a natural consequence.

The anconal side of the shaft is rather flatter than in *Aquila*, so that the bone does not exhibit quite such a great curve as the latter.

The quill knobs are obliterated.

Harpagornis assimilis. Pl. VIII., Figs. 3 and 4.

	Inches.
Total length	9·35
Circumference of proximal end	3·00
Circumference of distal end	2·32
Circumference of shaft where thinnest	1·48

The pachydermal character of the genus under consideration, when compared with *Aquila audax*, is well exhibited in this ulna, because, being actually shorter than the corresponding bone in the Australian species, it is much shorter in all its proportions.

The ulna of this species being better preserved than that of *Harpagornis moorei* has been figured by preference. The two rows of quill knobs, and

principally the one on the ulnar side, are well seen, as well as the intermuscular ridge on the palmar side, and the flat processes for the attachment of the muscles.

RADIUS.

Of the left radius of *Harpagornis moorei* we possess only a fragment of the proximal side. The proximal end is well expanded, and the tubercle for the insertion of the biceps stands considerably forward, the shaft becoming afterwards very flat towards the ulna, not being so much bent as in *Aquila.*

The radius of *Harpagornis assimilis* (Pl. VIII., Figs. 5 and 6), which has a total length of 7·62 inches, against 7·90 inches for the corresponding bone in *Aquila audax,* is, like the ulna, of much stouter proportions. It is more bent towards its distal extremity, so that the same stands at a greater angle to the shaft than any of the recent species.

METACARPUS. Pl. VIII., Fig. 7.

Only one specimen of the metacarpus belonging to *Harpagornis assimilis* was obtained, being in an excellent state of preservation.

It is not only a little longer than that of *Aquila,* but also much stouter in its proportions. This is most conspicuous in the medius metacarpal and the proximal end.

The process for the attachment of the index phalanx is broad and heart-shaped, and the two principal intermuscular ridges upon the medius metacarpal enclose a broad and well-defined channel.

PELVIS. Pl. IX., Figs. 1, 2, and 3.

In my introductory remarks I stated that all search after the pelvis of *Harpagornis moorei* had been unsuccessful, but that we were fortunate enough to obtain this important bone of the smaller species *H. assimilis* when excavating the other bones belonging to the latter.

Last year, when visiting the Colonial Museum in Wellington, I observed amongst the specimens of our extinct avi-fauna a perfect pelvis, which, on examination, I assigned to *Harpagornis.* Dr. Hector, at my request, allowed me to take this fine specimen with me for comparison and description. After placing it near the pelvis of *H. assimilis,* with which it agreed in all main points except its larger size—bearing the same proportion as the bones of *H. moorei* do to those of the smaller species—I had no hesitation in assigning it at once to the former.

This compound bone, belonging to a fully-grown but still young individual, has all the characteristics which belong to the pelvis of a diurnal raptorial bird, some of the complex features, owing to its enormous size, being developed in a most remarkable degree. It combines great strength with lightness and

elegance of form, of which the drawings attached to this memoir will convey an accurate conception better than words can do.

In the following pages I shall offer a description of the larger and perfect pelvis, which I assigned to *Harpagornis moorei*, whilst the references to that of the smaller *H. assimilis* will prove the close generic, if not specific, relations of both.

In comparing the pelvis of *H. moorei* with those of *Aquila audax*, the wedge-tailed Eagle of Australia, and of *Circus assimilis*, the Harrier, and *Hieracidea novæ zealandiæ*, the Sparrow-Hawk of New Zealand, as shown in the following table, the striking difference in size becomes at once manifest.

TABLE OF MEASUREMENTS, IN INCHES.

Pelvis of		Greatest Length.		Greatest Breadth.
Harpagarnis moorei	...	7·22	...	3·38
Aquila audax	...	4·75	...	2·55
Circus assimilis	...	2·75	...	1·40
Hieracidea novæ zealandiæ	...	2·00	...	1·15

When examining this table of measurements another peculiar feature of the fossil bone will present itself to our attention, namely, its great length when compared with its breadth; whilst in the three recent species the double breadth is more than the length, in *Harpagornis* it is considerably less. This peculiarity is produced principally by the greater steepness of the pelvic roof and by the comparatively greater length of the ilio-ischial plates; moreover, it is also higher in proportion than any of the recent species of Diurnal *Raptores* with which I could compare it.

When viewed from below the space formed by the hind part of the neurapophysial crest and the two ilia has an oval shape; whereas in the three recent species previously alluded to it is shorter, more open, and semicircular (*a*).

Beginning with the first sacral vertebra, we observe that the articular surface of its centrum is broader in a transverse than in a vertical direction, 0·69 inch by 0·58 inch. The neural canal has an oval form, its largest diameter, 0·21 inch, being in the vertical line, in this respect resembling *Circus;* whilst in *Aquila*, and still more in *Hieracidea*, the canal approaches the circular form.

The prezygapophyses (*pr.*) are of middle size and stand forward, their articular surface of a rounded shape, being almost plane. The neural spine is broad and strong at its base, gradually contracting, and forming only near its coalescence a small neurapophysial expansion lying between the iliac plates (*n*).

A broad and deep ilio-neural opening is formed on each side of the spinal plate, having a greater vertical than lateral extent, and here again differing from the pelvis of the three recent species previously alluded to, the roof

d. del. et lith.

HARPAGORNIS MOOREI

formed by the iliac plates of *Harpagornis* being consequently considerably steeper.

The surfaces for the head of the two free sacral ribs are strongly developed, the iliac roof extending, however, a little beyond them.

The under surface of the first sacral centrum in its anterior portion is slightly carinate, whilst the centres of the two succeeding ones are rounded, the edges of their articular surfaces being well raised, the posterior one of the third centre the least; after which they flatten and expand to the beginning of the interacetabular region, contracting again to its termination, and possessing a transversely concave, shallow, inferior surface, being broadest near the anterior articular surface of the seventh vertebra.

From the eleventh to the fourteenth they still diminish in breadth, and now exhibit a low but well marked inferior ridge, running out before the last sacral vertebra is reached.

The parapophyses of the third to the sixth sacral vertebra are anchylosed to the lower border of the ilia, forming four interapophysial vacuities on both sides; of these the last parapophysis is the strongest and thickest, standing at right angles to the direction of the axis of the vertebral column.

There is a short parapophysial process starting from the seventh vertebra (the first of the four next vertebræ forming the interacetabular region), which has a downward direction, and is still attached on the left side of the pelvis to the inner edge of the head of the pubic bone (*h*).

In the pelvis of *Harpagornis assimilis* this process does not exist, and it resembles in this respect the recent species previously used for comparison. Of the parapophyses of the last four vertebræ, forming the postacetabular region, the first one belonging to the eleventh sacral centrum is a filamentary bone (*m*) joining the second round and strongest parapophysis, which abuts against the innominate, and with which the posterior ones are also connected by their distal ends.

Of the interapophysial vacuities the first, second, and fourth are elongate, whilst the third and largest is more circular. In the smaller pelvis of *Harpagornis assimilis* these vacuities are not relatively, but actually, larger than in that of *H. moorei*.

The coalesced distal portion of these parapophyses runs in an oblique angle from the inner region of the ilia to the abutment of the twelfth sacral centrum, the space between this distal line and the upper side of the ischiadic foramen, below the pelvic disk, being spanned over by a thin deck of bone (*d*), perforated by a large oval opening 0·48 inch in its largest diameter, which runs parallel to the main axis of the pelvis, and is situated on each side behind the upper and anterior wall of the ischiadic foramen.

The last sacral vertebra of *H. moorei* is not yet quite anchylosed to the

foregoing vertebra, thus shewing that it belonged to a not quite adult individual; on the other hand, in the pelvis of *H. assimilis* the articular surfaces of these two last vertebræ are well anchylosed, and the junction of the parapophyses with the lower border of the ilia in its antacetabular part is also well accomplished, which is not quite the case in the pelvis of the larger species under review, so that we may safely assume that the former belonged to a full-grown mature specimen.

The gluteal ridge is decayed in *H. moorei*, but is well developed and preserved in the smaller species, the gluteal process forming a rounded knob (*g*), which rises well above the pelvic disk, whilst in *Aquila* this process has a convex form, directed downwards, and standing well in advance of the ilia. Of the recent species *Circus* resembles most, in this respect, the extinct gigantic form.

The pre-acetabular iliac plates unite about one-third from their anterior end above the summit of the sacral ridge, diverging again after having been united for 1·70 inch to form a small interposed neural expansion, anteriorly lying scarcely below the upper border of the iliac plates. In this respect it resembles *Aquila*, whilst in *Hieracidea*, and still more in *Circus*, the neural interposition is continuous all the way, but is narrowest in the region where, as observed, the iliac pre-acetabular plates meet in *Harpagornis.*

The ischium is very strongly developed at the back part of the acetabulum, as might be expected in a bird of such great strength. The tuberosity of the ischium, a roundish flat process, 0·72 inch from its posterior termination, rises conspicuously above its lamelliform surface (*k*). The posterior termination of the coalesced ischium and ilium is not rounded off, as in *Aquila*, but has a rather acute form, which, of recent species, *Circus*, and still more conspicuously *Hieracidea*, also possess.

The pubic bone, after forming the lower boundary of the obturator notch, gradually loses its trihedral shape and assumes a vertically flattened form, continuing to run for some distance parallel with the ischium; however, as in both specimens its posterior portion is broken off, I cannot say how far it may have extended. In any case it is longer than in *Aquila.*

A thin plate of bone, closely connected with the lower border of the ischium and gradually thickening, runs to the termination of that latter bone. At its beginning it forms the posterior boundary of the obturator foramen, and fills up the space between the ischium and the pubic bone.

The subacetabular fossæ *(f)*, which are very shallow in *Aquila* and the Diurnal *Raptores* now living in New Zealand, are deeply excavated. The pelvic disk is a strong bone separated on each side by a well-marked line from the hind part of the neurapophysial crest, which rises well above it, the latter showing, like all the rest of the bones of which the pelvis is formed, a

remarkable development of all the principal features to be observed in the pelvis of the smaller recent Diurnal *Raptores*.

Finally, I wish to observe that the pelvis of *Harpagornis moorei*, from Otago, has still some of its integuments and ligaments attached, of which the lining membrane on the walls of the acetabulum are best preserved; whereas the more fragmentary bone of *H. assimilis* is in the semi-fossil condition in which all the bones from the remarkable turbary deposits of Glenmark are usually found.

Since my former paper a second ungual phalanx has been obtained, which, applying the same mode of measurement previously used, is 2·75 inches long, and has a circumference of 2·92 inches at its proximal end. It is the third phalanx, and belongs to the second or inner toe of the right foot.

Amongst the smaller bones lately excavated I found also the second phalanx, with which that latter ungual phalanx articulates.

The pachydermal character, even in these toe-bones, is well sustained, and the form and peculiarities of the articular ends, and the large concavity behind and below the trochlear joints of the distal end, are developed in a striking degree.

Of *Harpagornis assimilis* we possess, as previously observed, several phalanges.

Description of Plates VII.—IX.

Plate VII.—Figs. 1–2. Tibia of *Harpagornis moorei.*
3–4. Metatarsus „ „
VIII.—Figs. 1–2. Humerus of *Harpagornis assimilis.*
3–4. Ulna „ „
5–6. Radius „ „
7. Metacarpus „ „
IX.—Figs. 1–3. Pelvis of *Harpagornis moorei.*

Art. XIII.—*On* Cnemiornis calcitrans, *Owen, showing its Affinity to the* Lamellirostrate Natatores. By James Hector, M.D., F.R.S.

Plates X.—XIV.A.

[*Read before the Wellington Philosophical Society, 18th August,* 1873.]

Since the discovery of the very interesting specimen of the Moa's neck with well-preserved muscular tissue and integuments in the Earnscleugh cave, in the interior of the Province of Otago,* the locality has been visited several times, and especially last year by the Hon. Captain Fraser, who obtained, besides Moa bones, several belonging to a smaller-sized bird, being part of a skeleton most of which had been previously removed by some gold-diggers. I recognised these to belong to *Cnemiornis calcitrans*, of Owen, the only difference being that the humerus differed from that described by Professor Owen† in several important characters.‡ Besides the humerus were the right femur and tarso-metatarsus and the metacarpal bones ; the two former agreeing accurately with Professor Owen's description and plates, and the last-mentioned being a new addition to the osteology of the bird. The chief difference in the humerus from that attributed to this bird by Professor Owen is its greater proportional size, it being equal in length to the femur, instead of one-ninth less, and in its having a very distinct pneumatic fossa, closed by a cribriform bony septum. In addition, the tuberosity representing the pectoral ridge is not so wide, and the proximal articular surface is slightly broader and more convex at its middle part than in the typical bone. These characters might lead to the surmise that it belonged to a carinate bird, but the massiveness of the bone was thought sufficient to disprove this. In order to determine this point with some degree of accuracy, I compared the weight with the bulk of the same bone in several species of birds, with the following results :—

	Weight.	Bulk.
1. *Cnemiornis* (Earnscleugh cave)	10	244
2. Weka *(Ocydromus)* (non-volant)	10	210
3. Kakapo *(Stringops)* (non-volant)	10	187
4. Kaka *(Nestor)* (volant)	10	131
5. Hawk *(Hieracidea)* (volant)	10	126

A small portion of the shaft was also removed, and the thickness of the bony wall found to be so great that the internal diameter is only two-thirds that of the external.

In consequence of the above divergence of character from the humerus described by Professor Owen, I was much interested in obtaining the

* Trans. N.Z. Inst., IV., 111. † Trans. Zool. Soc., V., 399, Pl. 66.
‡ Trans. N.Z. Inst., V., 406.

SKELETON OF CNEMIORNIS CALCITRANS

J B Lith

remainder of the bones of this skeleton, and, after tracing it through several hands, Captain Fraser at last succeeded in obtaining possession of the box containing the bones in the same state in which they had been found, and at once handed them over to me for description.

The skeleton is still far from complete, but the following bones are in a very admirable state of preservation :—Skull ; vertebræ, 12 cervical, 4 dorsal ; sternum ; furculum ; humerus, right ; metacarpal, right ; sacrum ; femur ; tibiæ, both ; tarso-metatarsal ; ribs, six.

They agree perfectly in appearance, colour, peculiar stains, texture, and other external characters, so that there is no reason to doubt that they all belong to one individual, which is further confirmed by the study of their anatomical characters.

The structure and form of the skull and sternum shew that this bird belongs to the *Lamellirostrate* family of the order *Natatores*, but that the power of flight had become obsolete, and that it differs from most others of the duck kind in its short, lofty head, very solid palate, and in the peculiar character of the tympanic cavity, which is bridged across by a bony process between the mastoid process and the basi-occipital. The great solidity of the skull, and the absence of occipital fontanelles and of all sutures excepting the naso-frontal and the lachrymal, is also remarkable.

Every bone of the skeleton, excepting the upper part of the sternum, has the close-grained, reticulated surface which is so characteristic of the bones of *Cnemiornis*, giving the impression of a very solid, powerful framework, that in the fresh state would contain much oily matter. The absence of the power of flight is evidenced by the rudimentary tubercular ridge that represents the keel, and the small area of attachment for the pectoral muscle on the surface of the sternum.

SKULL. Pl. XI.

What remains of the skull is well preserved, every process being sharp and distinct, as in a freshly-macerated specimen, but unfortunately the following appendages have been lost :—the quadrate, jugal, pterygoid, and lachrymal bones. The shape of the head, including the lower jaw, and allowing the usual proportion for the quadrate, would have been :—Height, two-thirds the length ; transverse diameter, one-half the length.

The brain-case is short, high, and compressed laterally, its posterior-inferior diameter being greatest. The nasal portion of the skull, which is distinctly shorter than the cranial, is detached ; and the mobility of the upper mandible, which in such birds is usually effected by the flexibility of the thin nasal bones, must, if it existed, have been effected by a straight joint with thick, irregular margins, somewhat as in the parrot.

In the occipital region the muscular ridges are moderately developed. The

condyle (*oc*) moderate, reniform, flattened, and excavated above, with a mesial notch, slightly excavated beneath, but not laterally.

The foramen (*Fm*) is very large, being one-third the height of the occiput in its vertical diameter, which is one-fourth greater than the transverse. It is rounded above, but has the lateral and inferior margins almost straight. The occipital area is rather square in form, with a blunt mesial ridge (*So*), having a shallow pit (*a*) on either side, but no fontanelles. A bold par-occipital process (*po*) extends downwards and backwards on each side, and forms the extremity of the cranium in that direction, giving rise to the most remarkable feature in its external conformation as viewed laterally. A deep perforated pit (*b*) separates this process from the basi-occipital, which is very largely developed, and has two inferior lateral processes (*l*) separated by a wide, smooth, sub-condylar notch (*c*), and then extends forward as a broad, slightly-concave surface, which occupies a large area at the base of the skull (*br*). The basi-sphenoid (*Bs*) has a small share in the base of the skull, and has large oval basi-pterygoid facets (*bp*) only slightly divergent.

The character presented by the tympanic fossa is very remarkable, as it is divided into a posterior and anterior portion by a quadrate ossicle (*ms*) that connects the tip of the mastoid process with the basi-occipital and with the anterior process of the ex-occipital, thus enclosing a wide canal descending obliquely backwards and outwards, with a sub-circular aperture deeply notched inferiorly. The articular portion of the tympanic fossa, with its two facets, is thus separated from the posterior or auricular portion, a character which appears to be unique.*

The frontal bone (*F*) is slightly swollen at the vertex and depressed between the orbits, which have strong overhanging orbital processes, on which are rough, deeply-impressed areas (*d*), which probably gave attachment to a posterior development of the cere of the mandible, these impressions being separated by a smooth groove with only a faint mesial ridge. There appears to have been a deep notch (*d'*) in the upper part of the orbital border, but the lachrymal bones having been lost this is not very clear. The width of the nasal suture (*Fn*) is equal to the length of that for the attachment of the lachrymals (*Fl*), which extends from the glandular groove to the transverse suture. The inter-orbital septum is complete, and there are well-ossified rhinal chambers (*Rh*). The roof of the orbit is flat, and with a very slight granular groove. The optic foramen is at the posterior and inner angle of the orbit, directly above the front of the basi-pterygoid facet. Behind the post-orbital process is a deep imperforate pit. The brain cavity extends for 6 lines anterior to the optic foramen. The upper mandible has all its elements completely fused; the large nostrils (*e*) occupy more than half of the superior sloping area, their

* I have since found it, but less marked, in *Cereopsis*.

Fig. 2

Fig. 3.

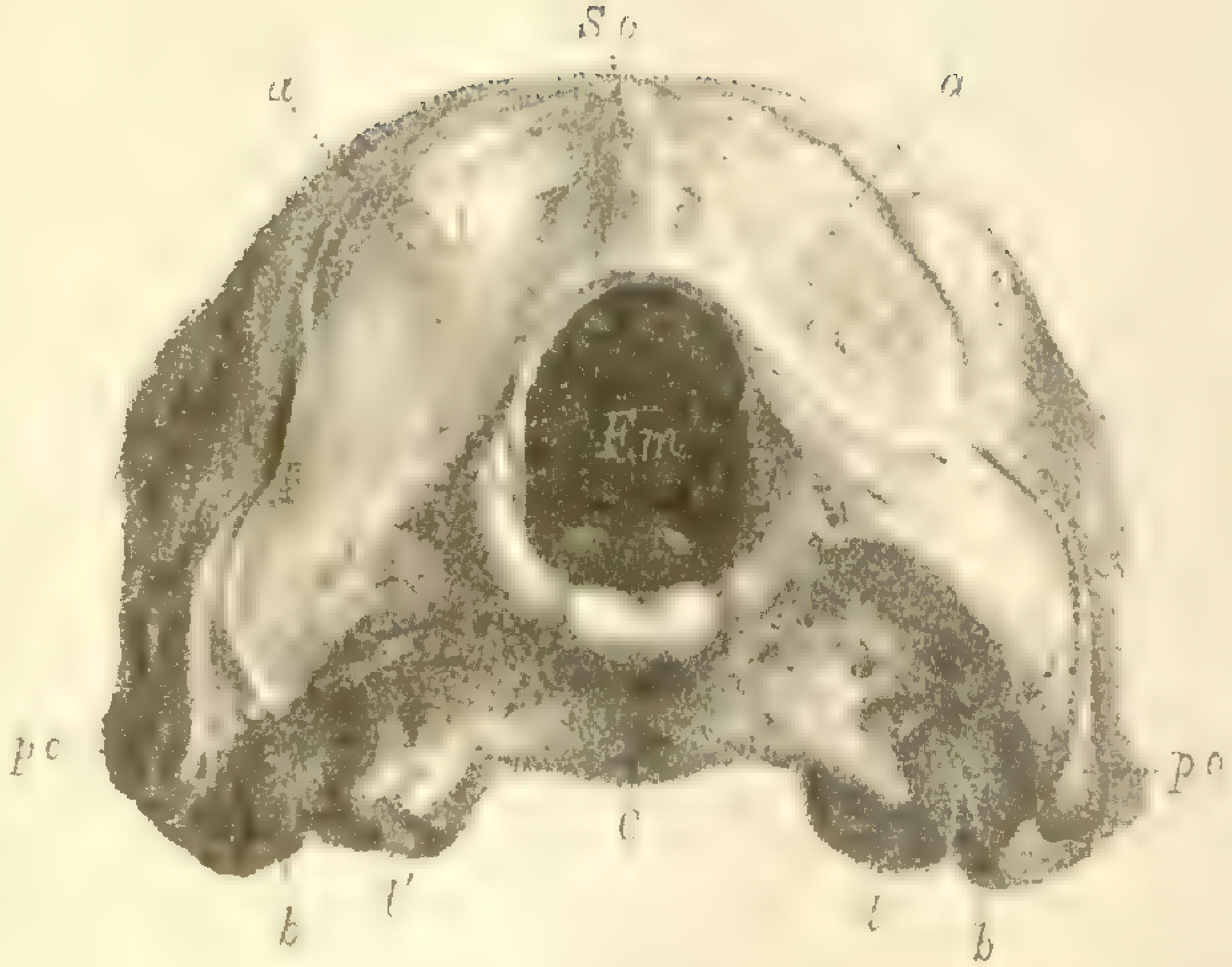
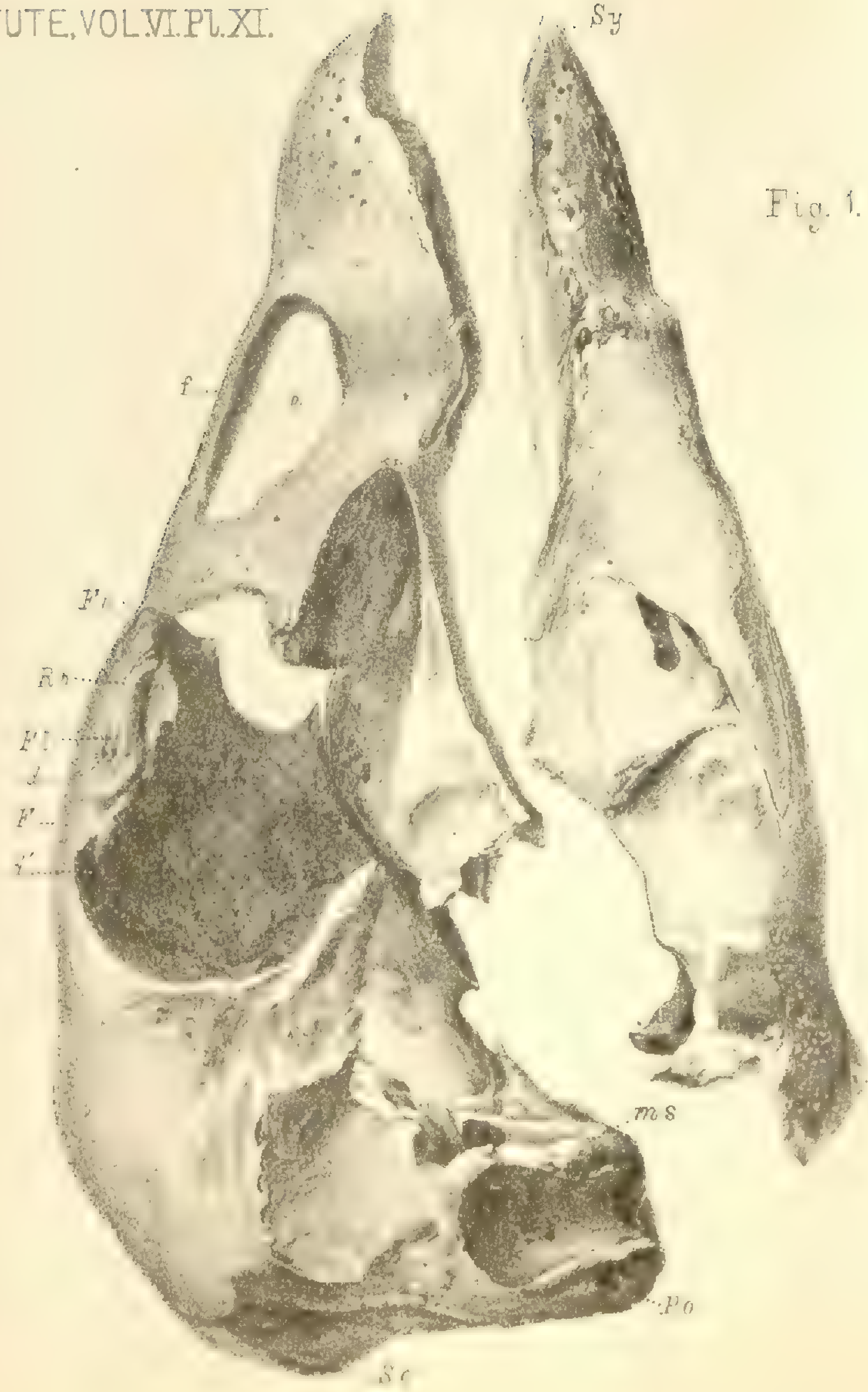


Fig. 1.



J.B. lith.

SKULL OF CNEMIORNIS CALCITRANS.

aperture being directed outwards, forwards, and upwards, rounded in front and angled behind, and they are separated by a smooth bony interspace *(f)* which is one-fourth the width of the mandible. The tip is rounded, with a tumid area for the attachment of the horny mandible, the length of which is equal to the width. Interiorly the palatal plate is flat, with deeply-incurved borders, notched on each side of the tip, and deeply excavated by a longitudinal groove (*h*), which is perforated by two well-defined apertures, the one (*h'*) large and directed upwards, the other (*h''*) small, directed backward in a line with the groove. The palatines are firmly united with the vomer, the upper surface of which has a slight groove to receive the pre-sphenoid.

The lower mandible is stout, but broad and compressed in every part, the rami preserving a lamellate structure throughout, and being united by a broad symphysis (*sy*), the length of which is equal to one-fourth of the mandible, the anterior half being flat and the posterior excavated. Inferiorly the punctate surface of attachment of the horny mandible covers the whole of the symphysial portion.

PELVIS. Pl. XIV.

This bone agrees with Professor Owen's description* so far as his imperfect specimen enabled him to fix its characters, but the complete preservation of the bone obtained from the Earnscleugh cave enables me to add the following:—

The neck of the ischium (*a*) is compressed to form the inferior notch, which is 9 lines in diameter, and contracted posteriorly (at *b*) to 5 lines. The ischium then expands to 8 lines, with a concave external surface, its upper margin being united with the ilium for the last two inches (*cd*), forming a rhomboidal convex plate with a thin posterior margin that descends obliquely backwards; the inferior margin is produced (*e*), and has been united by cartilage to the pubic styles for about 9 lines. The latter are attached by a stout compressed process to the inferior fifth of the acetabulum, and thence produced backwards as a narrow, curved bone, flat externally, and with a strong ridge internally, 3 lines wide at its narrowest part, and posteriorly expanding into a flat curved process that descends at an obtuse angle and continues the edge of the posterior pelvic aperture *(f)*. The coccygeal bones are wanting. The first sacral vertebra is anchylosed to the sacrum only by its spinous process.

The posterior roof of the pelvis is pierced by eight foramina in almost parallel lines an inch apart, separated by a concave interspace anteriorly and a convex ridge posteriorly; the rhomboidal form of the area being produced by a blunt expansion of the border which, on either side, overhangs the anti-trochanteric process.

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* *l. c.* p. 397.

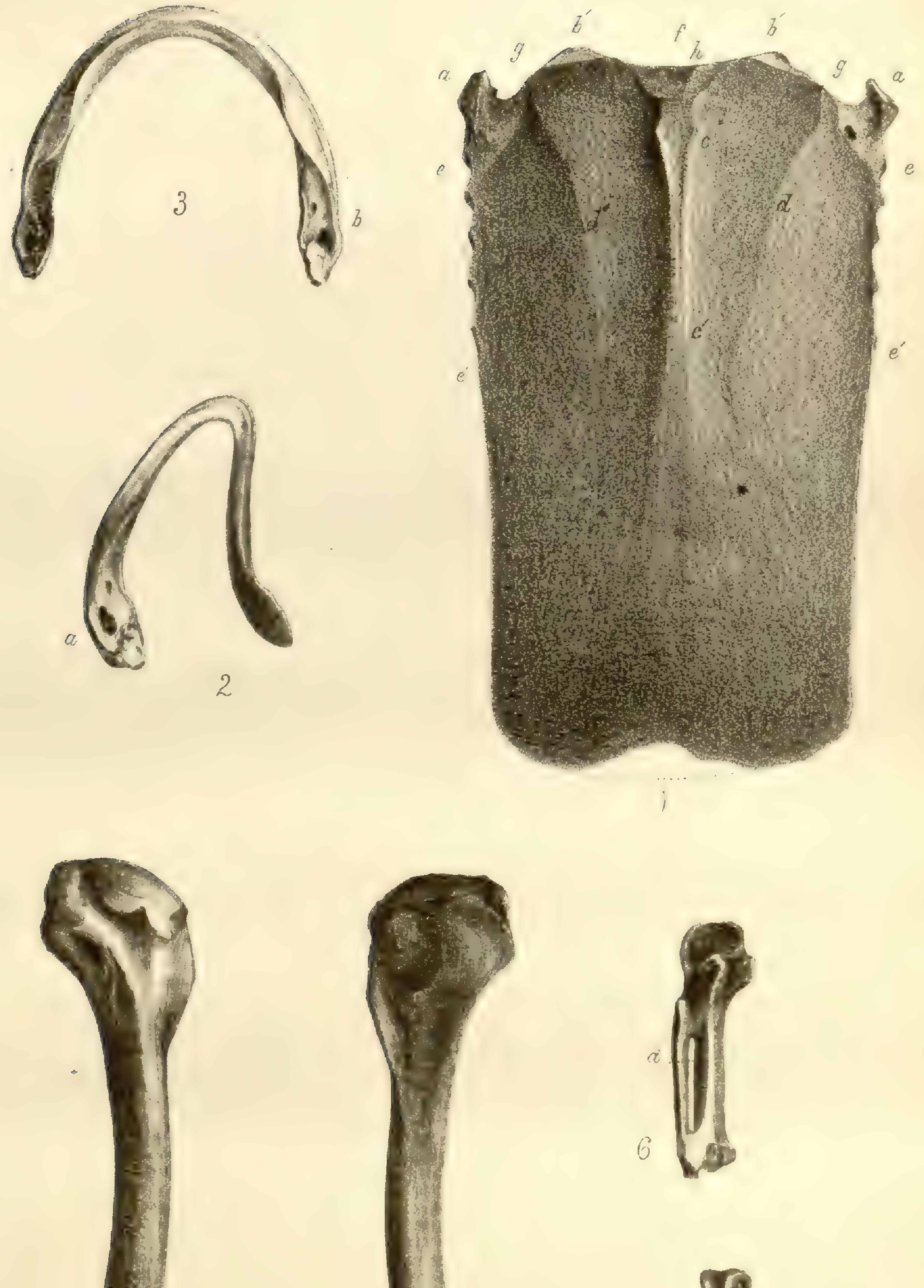
Sternum. Pl. XII., fig. 1, and XIII., figs. 1, 2.

This bone is almost perfect, having lost only a few lines of its inferior margin, and, though it differs considerably from the characters attributed to it by Professor Owen, this is, without doubt, due to his not having had a connected fragment of the superior portion of the bone, so that its enormous posterior concavity was not appreciated. It is chiefly remarkable for its regular oblong shape, without any irregularities of outline or unossified interspaces. The texture must be cancellated, for, though apparently thick and massive, it is very light in proportion to its size, as will be seen in the appended table. Its general form is scaphoid, the concavity being very marked in the upper half, amounting to one inch in depth measured from a transverse chord, and to one-and-a-half inches in depth if measured from a longitudinal chord; the total length of the latter being 7 inches. The anterior width at the costal processes (*a*) is 4 inches, and at the posterior end of the costal border 3 inches 6 lines.

The costal border (*e-e'*) occupies half the lateral margin of the bone, the posterior half of the line being only slightly concave interiorly, and exteriorly being flat in the middle and sloping very slightly to the inferior angles. The superior margin is thin, and presents a wide mesial notch (*f*) and two lateral notches (*g*), which are bounded exteriorly by the costal processes, which project backwards and upwards for 6 lines. The coracoid grooves (*b'*) are 1 inch 6 lines in length and 2 lines in depth of anterior border. They are separated by a slight triangular interspace (*f'*) 5 lines wide, beneath which is a smaller triangular pit (*h*). The keel (*c*) commences by two angular ridges bounding this pit posteriorly, and forms a blunt process 3 inches in length (*c-c'*), expanded anteriorly to a rough tuberculate surface 4 lines in width and 9 in length, and then compressed into a narrow tuberculate ridge that is gradually lost in the smooth convex surface of the bone at less than one-half the distance from its superior margin. The greatest elevation of the keel above the convex surface of the bone is less than 3 lines. The impression (*d*) for the attachment of the pectoral muscle extends from the exterior angle of the coracoid notch towards the posterior part of the keel, including a triangular area which occupies only one-sixth of the exterior surface of the bone, showing the extremely limited and feeble attachment of the great muscles of flight. Large pneumatic foramina (*i*) exist in the interior of the bone at the upper angles, and one (*i'*) on the exterior surface on the left side only.

Furculum. Pl. XII., figs. 2 and 3.

The clavicles are completely joined into a smooth, slightly-compressed furculum, like that of the goose, except that the antero-posterior curvature is confined to the articular processes, which diverge 1 inch above the general



CNEMIORNIS CALCITRANS.

J.B. del. et lith.

CNEMIORNIS CALCITRANS.

J. B. del. et lith.

plane, and are expanded with a large pneumatic foramen (*a*) on the external surface, overhanging which is a triangular articular surface (*b*). The coracoids have not been found, but must have been stout triangular bones 2 inches in length and 1½ inches wide at the sternal attachment. The scapula also is missing.

VERTEBRÆ.

The following vertebræ have been preserved:—The 2nd, 3rd, 5th, 6th, 7th, 8th, 10th, 11th, 13th, and 14th cervical; 2nd, 4th, 5th, and 6th rib-bearing or dorsal; the last having no hypapophysis may be termed the first of two pre-sacrals, the second of which is wanting. The total number of vertebræ seems to have been:—

Cervical	14
Dorsal	5
Pre-sacral	2
Sacral	17

The total length from the tip of the beak to the coccyx would be about 35 inches.

RIBS. Pl. XIII., figs. 3—7 and 7′.

The 3rd, 4th, and 5th ribs of the right side; the 6th and 7th of the left, and also the 7th sternal rib of the same side, have been preserved. The first six ribs have well pronounced uncinate processes (*a*) with a broad attachment one inch in length, that on the 6th rib (*a′*), being bent backwards so as to be almost parallel with the bone, and having a blunt expanded tip. The ribs are much compressed, their margins having wavy irregular outlines. They are broad in the middle and taper off towards each extremity, when viewed laterally. The last two ribs articulated with sacral segments, the total number having probably been nine. The number of sternal ribs was seven.

HUMERUS. Pl. XII., figs. 4 and 5.

The humerus has already been described, so far as it differs from the bone attributed to *Cnemiornis* by Professor Owen, and the femur, tibia, and tarso-metatarsal have been figured in Pl. XIV.A for convenience of reference by collectors. They agree so perfectly with Professor Owen's description as to require no further notice, except to point out that the external articular process of the metatarse, instead of being obliquely reflexed, as in the goose, swan, and other swimming birds, is straight, as in true cursorial birds, indicating that the habit of the bird was rather to walk on land than swim in water.

The metacarpal (figs. 6, 7) is made up of the first and second digits, which are completely fused at both extremities, leaving a narrow interspace (*a*) for less than half the length of the bone. It resembles closely the corresponding bone

in the weka (*Ocydromus*), and bears almost the same proportion as in that bird to the length of the humerus, or about two-fifths of the length of that bone.

I should state that this bone has been found in several instances in Canterbury by Dr. Haast associated with fragments of a similar humerus, and rightly assigned by him to *Cnemiornis.* A fragmentary skull, in which the basal, posterior, and nasal portions are wanting, and several leg bones, in the Colonial Museum—some found by Mr. W. D. Murison, in Otago, and others from the Wairarapa, in Wellington—must also be referred to this species, and prove that it was widely dispersed over both Islands of New Zealand.

As the leg bones of *Cnemiornis* are not infrequent in collections, especially from the most recent turbary and cave deposits, this bird must have been of common occurrence, and the foregoing details afford conclusive evidence that it was a gigantic bird, probably allied to and of similar habits to the Cape Barren Goose of Australia (*Cereopsis**), but in which the power of flight had become obsolete.

From the size of its pelvis, ribs, and sternum, the bulk of its body must have greatly exceeded in proportion any of its existing congeners, while its lower extremities were not less remarkable for their massive development. The height of its back above the ground exceeded 2 feet, and the length of the body from the beak to the tail was at least 32 inches.

Table of Admeasurements, in Inches.

Skull. Weight, 535 grains (with lower jaw).	
Length	4·5
Breadth across paroccipitals	2·0
„ „ post-frontals	2·0
„ „ temporal fossa	1·5
„ „ middle of upper mandible	1·5
„ „ tip „ „	1·0
Length from condyle to pre-sphenoid	2·1
„ of palatines	1·4
„ of pre-maxillary	1·5
„ from point of external nostril to end of pre-maxillary	1·0
„ of nasal aperture	0·8
Width of nasal aperture	0·4
„ of internasal septum—anterior	0·4
Supra-occipital tuberosity to post-nasal suture, following the curve	2·6
Supra-occipital tuberosity to external basilar process ...	1·6
Length of vertical basilar area	0·3
„ horizontal „	0·5
Width of „ „	1·3

* Having procured a skeleton of this species for comparison, through the kindness of Professor M'Coy, I am able to confirm this surmise. Among the chief structural differences, I notice the presence in *Cnemiornis* of an extra pre-sacral vertebra, so that two, instead of three, ribs articulate with the sacrum, and an elevated pent-roof arrangement of the *ossa innominata*, which indicate more decided cursorial habits.

CNEMIORNIS CALCITRANS.

J. B. del et lith.

Sternum. Weight, 1009 grains.

Extreme length of side	7·0
Extreme width at costal process	4·2
„ „ middle	3·7
„ „ posterior margin	3·6
Costal margins—length	3·0
„ width at middle	0·4
Coracoid grooves—length of each	1·5
„ interspace—inter-coracoid	0·6
Keel—length	2·5
Supra-carinal fossa—length	0·6
„ „ width	0·6
Height of arc	2·2

Furculum. Weight, 81 grains.

Vertical chord	2·8
Transverse chord	2·8
Total exterior length	7·0
Average diameter	0·3
Diameter of articular process	0·5

Humerus. Weight, 412 grains.

Length	6·2
Extreme breadth, proximal end	1·5
„ „ distal end	1·1
Circumference, middle of shaft	1·6

Metacarpal. Weight, 85 grains.

Length	1·5

Femur. Weight, 1021 grains.

Length	6·0

Tibia. Weight, 1789 grains.

Length	12·1

Tarso-metatarse. Weight, 787 grains.

Length	5·6

Ribs.

3rd—length	5·0
4th „	5·5
5th „	6·0
6th „	6·4
7th „	6·8
7th sternal—length	4·6

Vertebræ.	2nd Cervical.	14th Cervical.	2nd Dorsal.	1st Pre-sacral.
Transverse diameter of centrum	0·25	0·6	0·8	0·6
Breadth through transverse process	0·8	1·7	1·8	1·9
Antero-posterior diameter, or height of centrum	0·2	0·4	0·4	0·6
Total height	0·7	1·3	1·6	2·4
Length of centrum	0·9	0·8	0·7	0·7

Pelvis. Weight, 2400 grains.

Total length	11·3
Antacetabular	4·1
Acetabulum	1·1

Height through acetabulum	2·5
Antitrochanteric width	3·1
Mesial iliac suture	3·7
Post-sacral area—length	4·7
" " width between anterior lateral foramina ...	1·2
" " width between posterior lateral foramina	1·1
Ischiatic notch—breadth	1·2
" " length	3·0
Pubic style—length	7·5
" breadth, greatest	0·5
" " at middle	0·3
Superior posterior iliac interspace	0·8
Inferior " " "	2·2
" " inter-ischiatic space	3·8
Posterior pubic interspace	2·0
Ilium—anterior width	2·0
" posterior width at middle	1·0
1st sacral vertebra—height of centrum	0·7
" " " neural canal and spine ...	2·0
" " width of centrum	0·6
" " " transverse processes ...	2·0
Length of 8 anterior sacrals	3·5

Description of Plates X.—XIV.A.

(*Cnemiornis calcitrans.*)

Plate X.—Restored skeleton one-fifth nat. size, from a photograph.

XI.—Skull, nat. size.

Fig. 1. Side. Fig. 2. Inferior. Fig. 3. Posterior.

XII.—Fig. 1. Sternum, front view.

2–3. Furculum.

4–5. Humerus.

6–7. Metacarpus.

XIII.—Fig. 1. Sternum, side view.

2. Inner side of right costal process.

3–5. 3rd, 4th, and 5th ribs of right side.

6–7. 6th and 7th ribs of left side.

7′. 7th sternal rib of left side.

XIV.—Figs. 1–3. Pelvis.

XIV.A.—Figs. 1–2. Femur.

3–4. Tibia.

5–6. Tarso-metatarse.

Erratum.—The words "Weight" and "Bulk" in the table on page 76 should be transposed, the bulk of the bone being reduced to the same number in each case for comparison. The bulk was ascertained by immersing the bone in water after coating it with a film of wax, and ascertaining the displacement by weight.

CNEMIORNIS CALCITRANS.

ART. XIV.—*Notes on Delphinus forsteri.* By JAMES HECTOR, M.D., F.R.S.

[*Read before the Wellington Philosophical Society, 22nd September,* 1873.]

IN March last a specimen of *Delphinus forsteri*, which was cast up on the beach at Lyall Bay, gave me, for the first time, an opportunity of observing its external characters and of having a sketch made, which does not, however, differ sufficiently from that copied last year after Forster to make it worth reproduction (Vol. V., Pl. 3). Unfortunately the colouring had faded, so that the whole skin was of a dark tint, and the spots on the fins, mentioned by Forster, could not be distinguished. The skull, however, since prepared agrees exactly with that which I have already described as belonging to Forster's Dolphin, although the drawing given in the last volume of Transactions, of the first skull I had, does not show the full width behind the notch.

The following are the notes I made of its characters :—

Beak sharply defined above by a frontal groove. Forehead very curved. Fore part of the body fullest. Hind part of the body much compressed vertically, being 6 inches in advance of the tail lobes, 6 inches high, and only 2 inches thick. Tail strongly keeled, both above and below ; notched. Lower jaw longest. Length of pectoral equal to gape, and greater than height of the dorsal.

	Ft.	in.
Male.—Total length	7	2
Snout, upper surface	0	5·5
Blow-hole from tip of beak	1	1·5
Commencement of dorsal at	3	1·5
Base of dorsal—length	1	0
Height of dorsal (posterior edge being nearly vertical) ...	0	8·5
Insertion of pectoral from beak	1	5·5
Length of pectoral	1	0
Width " (constricted at base)	0	4
Generative organs, behind posterior vertical of pectoral	0	9
Width of tail-lobes from tip to tip	1	6

The complete skeleton of this specimen is being prepared, and will be the subject of a further communication. I may say, for the present, that the intermaxillaries, as in all the skulls of this dolphin I have previously seen, are united to form a bony tube for fully one-third of their length.

Art. XV.—*Notice of a Variation in the Dentition of* Mesoplodon hectori, *Gray.* By James Hector, M.D., F.R.S.

Plate XV.A.

[*Read before the Wellington Philosophical Society, 13th October,* 1873.]

This specimen is only a fragment of the lower jaw, but the portions preserved afford sufficient characters to determine the genus, and to show that it differs from any described specimen, and also throw some light on the little known subject of the dentition of the *Ziphiidæ.*

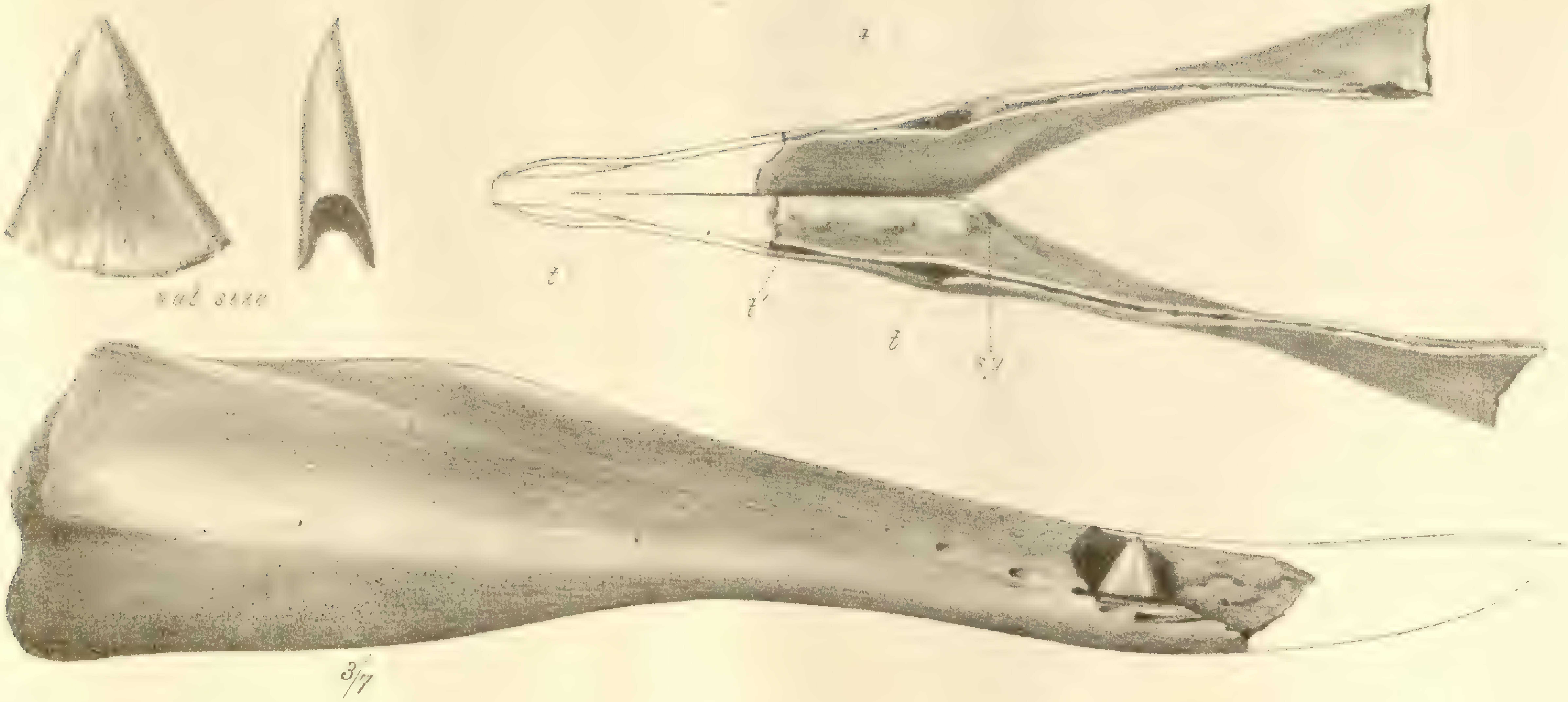
The posterior portion of the left ramus from the condyle to the symphysis, and the middle portion of the right ramus, is all that remains. About two inches of the surface of the suture enable the angle of divergence of the jaws to be determined, and, therefore, the width of the cranial articulation.

Opposite the commencement of the symphysis (*sy*) was a deeply excavated alveolus, which, in the left side, contains a triangular tooth (*t*). The dental groove has evidently been open and deeply excavated in the back part of the jaw, and where broken off on both sides, it appears as if it was expanding to form a second tooth chamber (*t'*).

Left Ramus.—The condyle is very feeble, but not more so than in *M. hectori*, to which the jaw bone is very similar except as regards the teeth.* The articular surface is 1·3 inches long and 0·3 inch wide, and situated above the middle of the posterior border, which is convex externally and 4 inches in length. On the inside the posterior third of the bone is deeply excavated, very thin, and on the outer surface shows one large inferior and a small superior ridge. The upper margin is compressed, thin, and elevated to form a blunt angle, behind which the dental groove begins at 6 inches from the condyle. The inferior margin is rounded, but with a blunt keel-like ridge, and slopes up rapidly, reducing the width of the ramus from 3·3 inches posteriorly to 1·5 inches in its middle third. This middle third is solid, compressed, and obliquely turned like a ploughshare, so that at the symphysis the dental grooves are on the outer side of the jaws 2 inches apart, and separated by a flat area formed by the symphysial processes, which are conjoined to form the terminal portion of the lower beak. The width at the condyles was probably 8 inches; length to the symphysis, 12·5 inches.

Tooth.—The chief interest of this specimen is the dentition, as in this it differs from the type specimen both in the position and character of the tooth. In the first respect it resembles the original type of the genus *M. sowerbyensis*, as the tip of the tooth (*t*) is exactly opposite to the posterior end of the symphysis (*sy*). Behind it the dental groove, though distinctly visible, is quite closed, but it

* Trans. N.Z. Inst., Vol. II., p. 27; Vol. III., p. 125; Vol. V., p. 167.



MESOPLODON HECTORI, *Gray.*

Var. lower jaw.

J.B. del. et lith.

dilates to form a dental cavity, in which the tooth is lodged, its tip only reaching to the level of the upper edge of the jaw. It occupied the cavity loosely, but could not be removed without breaking the bone. The tooth (figs. 3 and 4) is a very thin, hollow, conical shell, compressed, but not filled with solid dentine as in previous specimens. The tip is smooth and enamelled. The height is 1·2 inches; width, 1·0; and its thickness, 0·3.

The tooth shows the specimen to have been a young animal, and this will account for the slightly smaller size and different proportions of the jaw from the type; and the posterior, instead of the terminal, position of the tooth shows that probably several existed on each side, and that the dental characters in this group of whales are not constant or sufficiently important to form the basis of specific distinction. At the same time it is interesting to find that, even in the young state, this whale has the compressed form of teeth and the same mode of their arrangement which obtains in *Berardius*, to which genus it was at first referred.*

This specimen was found on the beach at Kaikoura, and forwarded to the Museum by Mr. J. R. W. Taylor.

ART. XVI.—*List of Seals, Whales, and Dolphins of New Zealand.* By J. E. Gray, Ph.D., F.R.S., Hon.Mem.N.Z.Inst.

[*Read before the Wellington Philosophical Society, 6th August*, 1873.]

THE fauna of New Zealand, as regards marine mammalia, is extending, and I have no doubt will be found to be much richer as they become more studied. For example, we have not yet had the "Sulphur Bottom" or the "Trigger" of New Zealand whales, and there are other species mentioned as found in those seas, but in such a manner as not to be able to be entered in scientific catalogues. There are many more species recorded as inhabiting Australian seas, which, no doubt, range as far as New Zealand, but I have only inserted these on the authority of specimens.

1. *Stenorhynchus leptonyx.*—The Sea Leopard, Gray, Cat. Seals and Whales, p. 16; Webb, Trans. N.Z. Inst., II., p. 29; Fraser, l. c., p. 33.

   Habitat—New Zealand, Port Nicholson (F. Knox).

   Skull in British Museum. [Skeleton in Colonial Museum]

2. *Arctocephalus cinereus.*—The Grey Australian Fur Seal. *Otaria cinerea*, Perron and Le Sueur; Quoy and Gaimard, Voy. Astrolabe, t. xii., xiii., xiv.; Hector, Trans. N.Z. Inst., IV., pl. 12, f. 1 (skull); not Gray,

* Trans. N.Z. Inst., Vol. III., p. 108.

Suppl. Cat. Seals and Whales, p. 24; *Phoca ursina*, Forster, Cook's Voy.; *Otaria forsteri*, Lesson, Dict. Class. Hist. Nat., xiii., p. 421; *Phoca forsteri*, Fischer, Synops. Mam., p. 232; *Arctocephalus forsteri*, Gray, Ann. Nat. Hist., 1868, i., p. 219.

Habitat—New Zealand, Milford Sound (Hector).

Skull in Col. Museum, Wellington, and Brit. Mus.

3. *Gypsophoca subtropicalis.*—The Small Fur Seal, Gray, P.Z.S., 1872.

Arctocephalus (Gypsophoca) cinereus, Gray, Suppl. Cat. Seals and Whales, p. 24, not synonyms.

Arctocephalus cinereus (young), Hector, Trans. N.Z. Inst., IV., t. xii., f. 2.

Habitat—New Zealand, Auckland Islands (Hector).

Skull in Col. Mus., Wellington.

North Australia (MacGillivray).

Specimens in Brit. Mus. from North Australia.

4. *Neobalæna marginata*, Gray, Cat. Seals and Whales, p. 90; Suppl., p. 40; t. 1, 2 (skull); Hector, Trans. N.Z. Inst., 1869, p. 26, t. iib. f. 1–4.

Habitat—New Zealand, island of Kawau (Hector); and West Australia.

Skull in Col. Mus., Wellington.

5. *Caperea antipodarum*, Gray, Cat. Seals and Whales, p. 101, f. 9, (ear bone); Suppl., p. 45.

Habitat—Otago.

Ear bone in Brit. Mus.; ? skeleton in Mus., Paris.

6. *Macleayius australiensis*, Gray, Cat. Seals and Whales, p. 105, f. 10, 11, and p. 371, f. 74, 75. P.Z.S., 1872.

Habitat—New Zealand (Haast).

Skeleton in Brit. Mus.

7. ——— ? *Balæna antipodarum* (ear bones only), Van Beneden, Ost. Cét, t. 111, f. 12, 14.

Habitat—New Zealand.

Ear bones in Mus., Brussels.

8. *Megaptera novæ zelandiæ*, Gray, Cat. Seals and Whales, p. 120, f. 20 (ear bone and os petrosum).

Habitat—New Zealand.

Ear bone and os petrosum in Brit. Mus.

Physalus antarcticus, Gray, Cat. Cet. B. M., 1850, p. 43; Cat. Seals and Whales, p. 164. The "finner," Dieffenbach (Knox).

Inhabits New Zealand. Only known from some yellowish white baleen or whalebone, Gray, l. c.

The Trigger-fin, *Rorqualus* sp., of Knox, (Trans. N.Z. Inst., II., p. 25) belongs to this species, but the osteology was not studied, and no specimens have reached the British Museum.

9. *Electra clancula*, Gray, Suppl. Cat. Seals and Whales, p. 77; *Lagenorhynchus clanculus*, Hector, Trans. N.Z. Inst., 1870, p. 27; *Delphinus superciliosus*, Lesson.

Habitat—New Zealand.

Skeleton in Col. Museum, Wellington.

10. *Globiocephalus macrorhynchus*, Gray, Cat. Seals and Whales, p. 320; Gervais, Ost. Cét., t. 52; Hector, Trans. N.Z. Inst., II., 1870, p. 38.

Habitat—New Zealand.

Two skulls in Col. Museum, Wellington.

11. *Beluga?* Hector, Ann. and Mag. Nat. Hist., 1872, ix., p. 430.

Habitat—New Zealand, Wellington (Hector).

This is very likely *Beluga kingii*, Gray, Cat. Seals and Whales, p. 300; Syn. Whales and Dolphins, p. 9, t. 7 (skull), of which we have a skull in the British Museum from Australia, brought home by Captain Parker King, R.N.

12. *Berardius arnuxi*, Gray, Cat. Seals and Whales, p. 348, f. 70 (skull); Gervais, Ost. Cét. (skull), Knox and Hector, Trans. N.Z. Inst., II., p. 27; III., p. 125, t. xvi., xvii.; Haast, Trans. N.Z. Inst., II., p 190.

Habitat—New Zealand, Port Nicholson, Porirua Harbour (Knox); Canterbury (Haast).

Skeleton in Mus. Roy. Coll. Surg. Skull in Col. Mus., Wellington.

13. *Berardius hectorii*, Gray, Ann. and Mag. Nat. Hist., 1871, viii., p. 117; ? *Berardius arnuxii* (part), Knox and Hector, Trans. N.Z. Inst., III., p. 108, t. 14, 15.

Habitat—Cook Strait, Titai Bay (Knox).

Length, 9 feet. The lower jaw is narrow in front, gradually becoming wider behind, and with a distinct gonyx at the end of the symphysis.

The lower jaws of the two Ziphioid whales figured by Dr. Hector have only a tooth at the front end, instead of a tooth at the front and one a little further behind on the side of the jaw, as is usual in *Berardius*. Perhaps this depends on age. The having only two teeth quite in front of the lower jaw is the character of *Epiodon*, but that has a sub-cylindrical tooth, and Dr. Hector's animals both have compressed triangular teeth like *Berardius*, as figured in his plates, so that if they are not *Berardius* they are a new genus.

Mesoplodon longirostris, of Krefft, of a skeleton of which in the Australian Museum of Sydney he sent me a very beautiful photograph, appears to be either *Berardius hectorii* or a new species. The photograph does not show any teeth. The beak of the Australian specimen appears to be longer, viz., nearly twice as long as the head, whereas the beak figured by Hector is but little more than one-and-a-half times as long as the head.

ART. XVII.—*Notice of the Skeleton of the New Zealand Right Whale* (Macleayius australiensis).

By J. E. GRAY, Ph.D., F.R.S., Hon.Mem.N.Z.Inst.

Plates XVI., XVII.

[*Read before the Wellington Philosophical Society, 6th August,* 1873.]

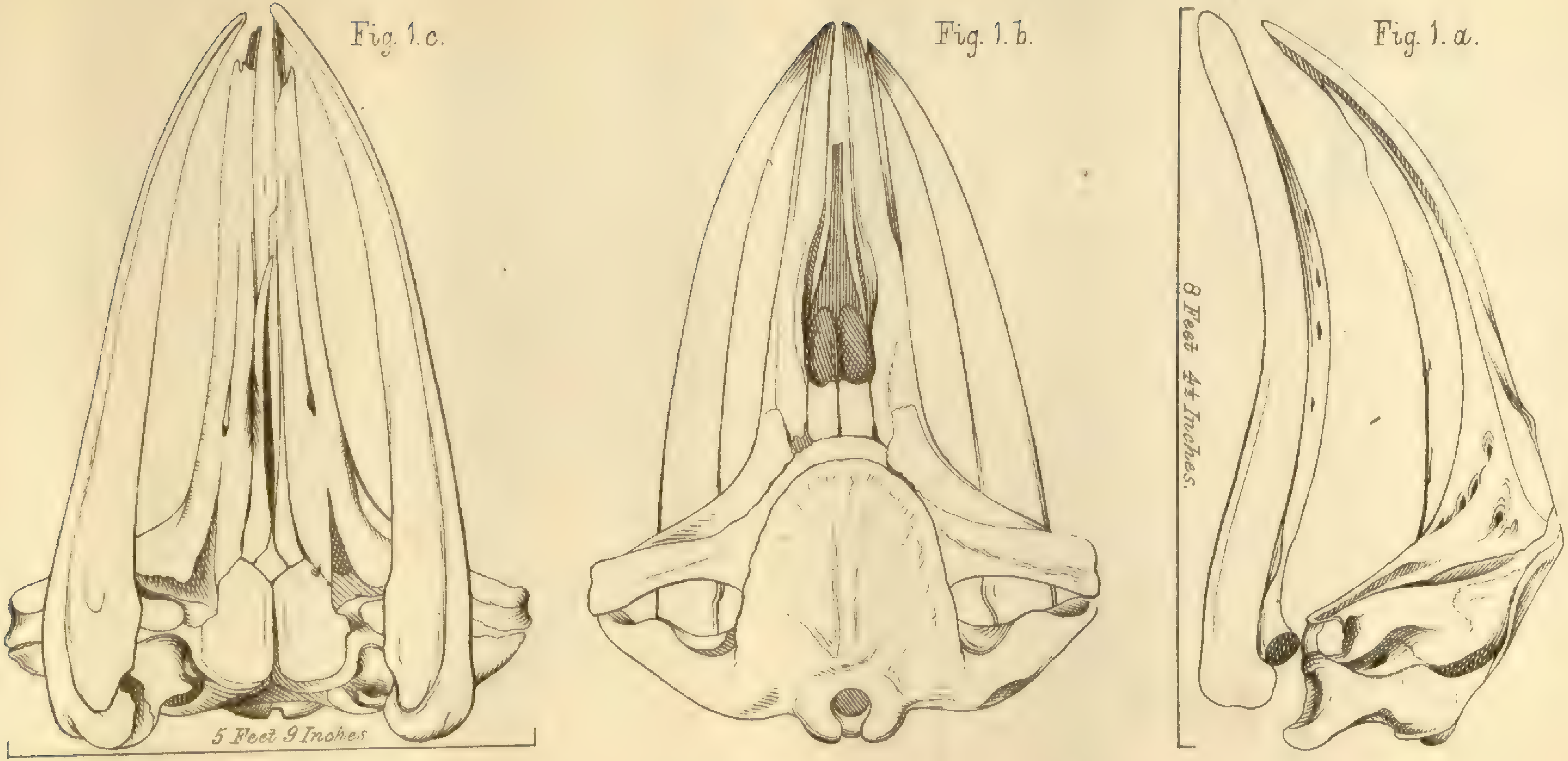
DR. HAAST has sent to England the skeleton of a whale from the coast of New Zealand. This skeleton is now in the collection of the British Museum. When first imported it was believed to be the New Zealandic whale, which I described and figured in Dr. Dieffenbach's "Voyage" under the name of *Balæna antipodarum*, which has been formed into the genus *Caperea*, on account of the peculiar shape of its ear bones. The examination of the ear bones at once showed that it was not that species, and proved that there were two Right Whales inhabiting the coast of New Zealand. The ear bone is so similar to those of *Eubalæna australis*, said to come from South Africa, in the British Museum, that it seemed as though it might be a specimen of that species, showing that it was common to the Cape of Good Hope and New Zealand. The examination, however, of the mass formed by the cervical vertebræ, and the form of the blade bone, showed that it was most distinct from the New Zealand and the Cape Whale; but it was soon apparent that the mass of cervical vertebræ very much resembled a similar specimen in the Australian Museum, at Sydney, of which Mr. Krefft had sent me four photographs, and which are copied in the "Catalogue of Seals and Whales" (p. 105, figs. 10 and 11; and p. 372, figs. 74 and 75), and described under the name of *Macleayius australiensis.*

The specimen now received chiefly differs from the photographs in the cervical vertebræ being much smaller but more complete, and in the lower processes of the second vertebra being longer and rather tapering at the end; but this may depend upon the age of the specimen, as the end of the process in this specimen is rugose, as if in progress of growth. I am, therefore, inclined to consider it as a specimen of the same species, or genus at least.

The specimen photographed by Mr. Krefft is much larger, and probably much more adult than the one we have received from New Zealand, as shown below:—

	Krefft.	British Museum.
Width of atlas	about 25 inches.	about 19 inches.
,, lower processes of 2nd vertebra	,, 28·5 ,,	,, 19 ,,
Height from base of atlas to top of crest	,, 18 ,,	,, 15 ,,

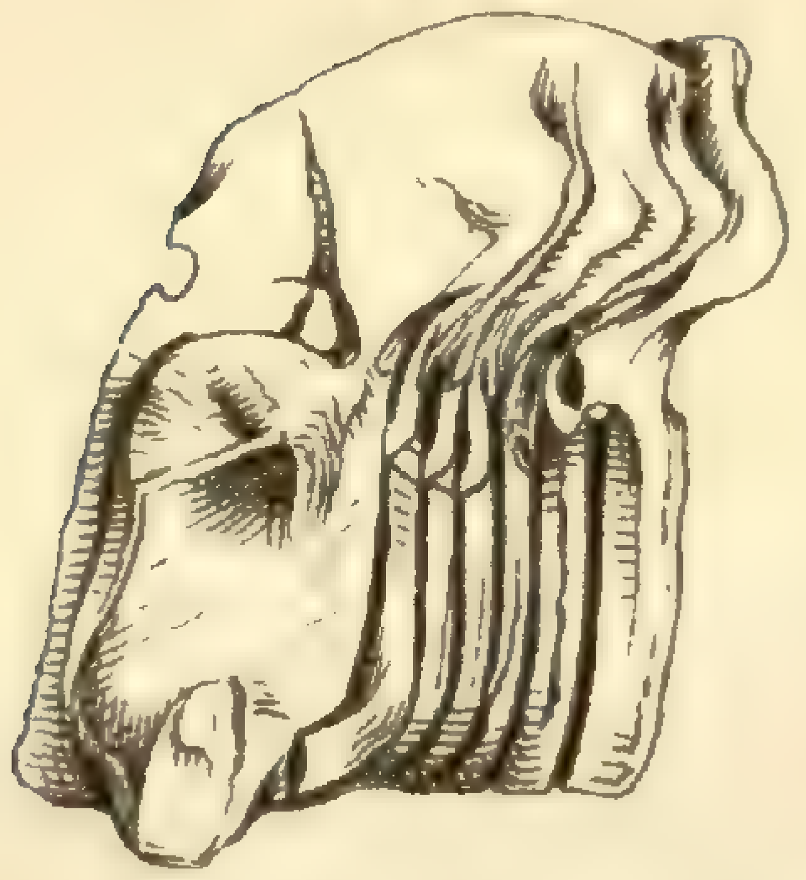
The total length of the vertebræ of the New Zealandic specimen, placed close together, is 31 feet 6 inches. The length of the head 8 feet 6 inches,



SKULL OF MACLEAYIUS AUSTRALIENSIS.
Illustrating Paper by Dr. J.E. Gray, on New Zealand Whales.

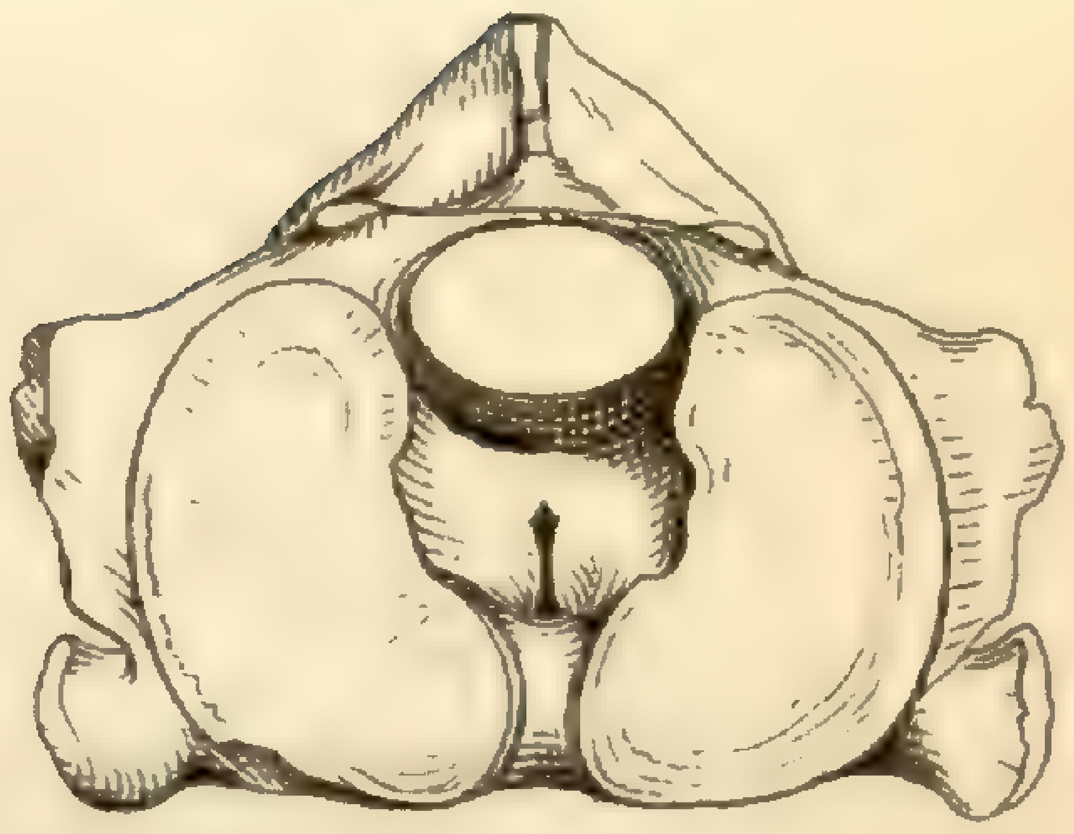
J.B.Lith.

Fig. 2. a.



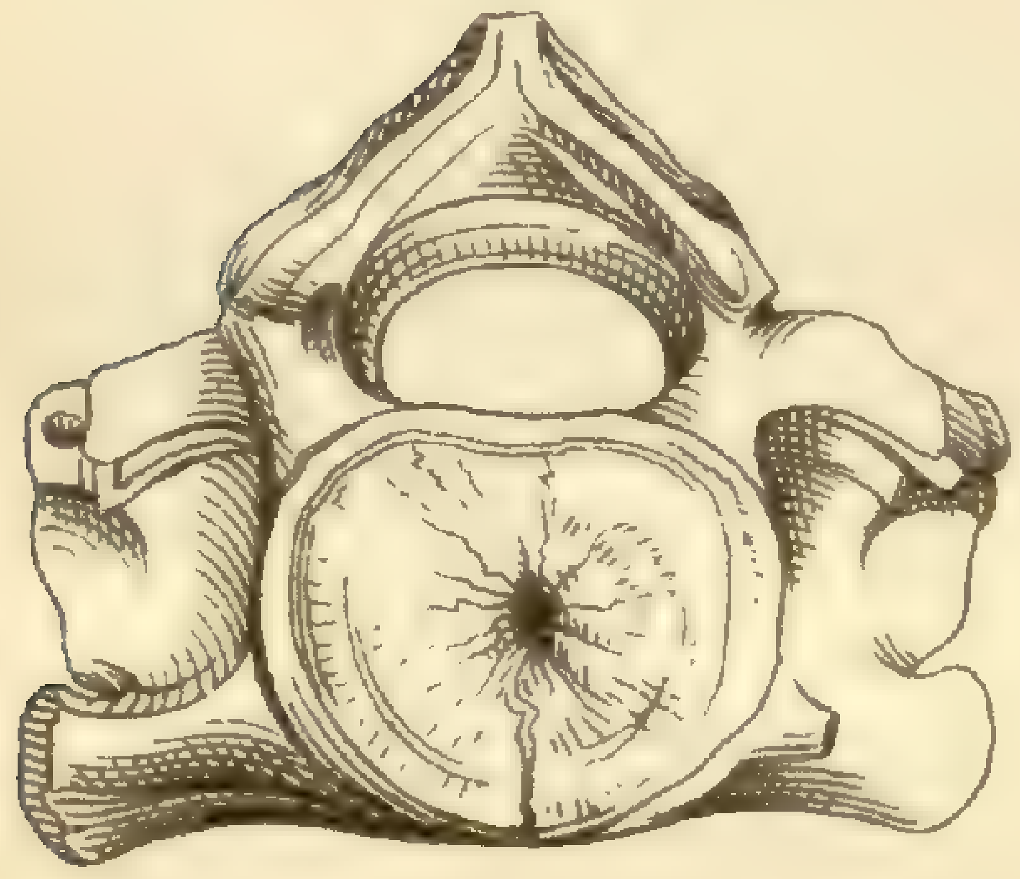
Cervical vertebræ of Macleayius australiensis. (side view.)

Fig. 2. b.



Cervical vertebræ of Macleayius australiensis. (front view.)

Fig. 2. c.

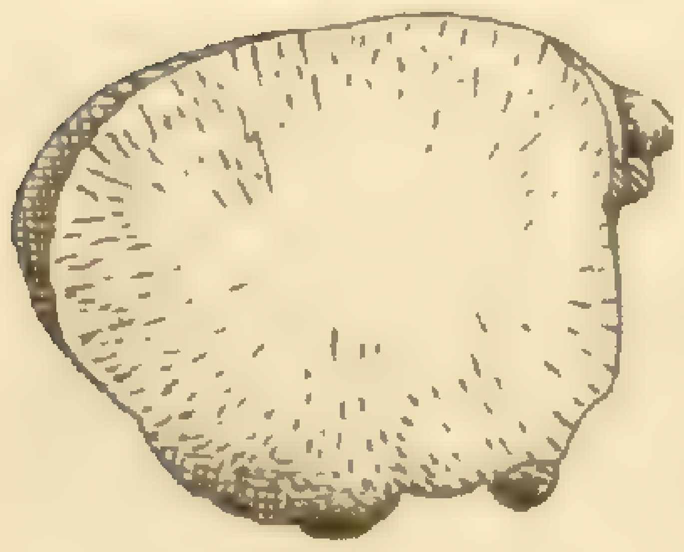


Cervical vertebræ of Macleayius australiensis. (back view)

Fig. 4.

Scapula of Macleayius australiensis. (inside.)

Fig. 3.



Sternum of Macleayius australiensis.

Illustrating Paper by Dr. J.E. Gray. on New Zealand Whales.

J.B. Lith.

but over the curve of the nose 10 feet. The length of the vertebræ, 23 feet; of the lower jaws, 7 feet 8 inches; of the first rib, 3 feet 6 inches; and of the middle rib, 7 feet 4 inches, as measured by Mr. E. Gerrard, jun., who observes that "the last small bone of the tail is wanting. There are eight chevron bones present, but I should think there ought to be one or two more small ones. One malar bone and the epiphyses of three vertebræ are wanting. I also think a few of the finger-joints are wanting, but it is difficult to be sure, as some are loose and others covered with skin;" but we will determine when it is cleaned. The nasal bone is strap-shaped, more than twice as long as broad, with thick rounded front ends which are notched out in the middle. It is about 4¼ inches wide. The skull and lower jaw weigh rather above 5½ cwt., each lower jaw being 90 lbs. The ear bone is very thick, triangular, with nearly equal sides. This is very like two ear bones which we have received from South Africa as those of the S. African Whale, *Eubalæna australis*, and the figures of the ear bones of that species given by Van Beneden (Ostéogr. Cét., t. I.; II., figs. 13 and 14). The differences between the New Zealand and the Cape Whales are so slight that it would be very difficult to express them in words, and indeed to distinguish the specimens from each other.

According to Van Beneden, the ear bones of the young *Eubalæna australis* are much more rounded, and have larger apertures compared with their size, than in the adults (see his figure t. 1 and 2, figs. 10 and 11).

The *os petrosum*, to which the New Zealandic specimen is attached, is very like, but rather smaller than the specimens we have of *Eubalæna australis*, said to come from the Cape, and like those figured by Van Beneden (Ostéogr. Cét., t. I.; t. II., figs. 13 and 14). We have a pair in the Museum very similar to the Cape and New Zealand bones, sent to the Museum as ear bones of the Sperm Whale, by Mr. H. H. Russell, but they differ from the three other specimens in having a much larger *os petrosum* and much longer strap-shaped truncated lobe.

The vertebræ are—seven cervical and forty-seven dorsal and caudal. The body of the first dorsal vertebra is anchylosed with the body of the seventh cervical, and there may be a last caudal vertebra wanting.

The cervical vertebræ are all united into one mass, and to the first dorsal vertebra by their bodies, and, all but the first dorsal, by the crests of the dorsal processes, which form a high arched ridge; the crest of the second vertebra being much the largest, longest, and highest. All the vertebræ are furnished with a superior lateral process, that of the first and second being free at the base and united at the end; that of the first very large, compressed, and truncated at the end. The upper one of the second, large, thick, and united to the upper part of the back of the process of the first. The upper lateral processes of the third to the seventh, compressed, slender, and free; the third

being free half-way up the crest, and others more or less free to the crest itself. The lower process of the atlas, or first, entirely wanting ; that of the second, large, thick, but compressed and truncated at the end, but probably in process of growth about as prominent as the upper process of the first. The lower process of the third, well developed, elongate, straight, much compressed, and truncated at the end ; about one inch shorter than the large process of the second. The bodies of the fourth to the seventh vertebræ without any indications of inferior lateral processes.

The bodies of the third to the seventh vertebræ, very thin, not much more than half the thickness of that of the first dorsal vertebra, which is anchylosed to the last cervical vertebra. The neural arch and upper lateral process, which is similar in form to that of the last cervical vertebra, but much thicker and stronger, is entirely free. The articulating surface of this vertebra is nearly circular, being only a little wider than high. The front of the neural canal is nearly circular, but rather depressed—that is, a little wider than high, but regularly rounded. The canal at the hinder end of the vertebral mass is larger, rounded, but with a rather triangular top, and a little wider than high.

The first rib has a single head, and is wider at the sternal end.

The sternum is oblong, rather irregular in shape and thickness, being thicker on one side than the other, very spongy or rather—full of cylindrical tubular cavities. There are three convex cylindrical prominences of nearly equal size, placed without any apparent order, on its thick margin. It is rather curved, the surface is flat, but the lower one is rather distorted by the unequal thickness of the bone. It is 6½ inches long, and about 5 inches wide.

The scapula is triangular, with a rounded end, rather broader than long—that is to say, 25 inches high and 27 inches broad at the widest end. The front margin has a broad compressed acromion process, which is bent towards the articulating surface and acute at the end, with a large arched outline which occupies about half the front margin. The disk of the outer surface is concave, with a large concavity in the middle of the upper half. The inner surface is nearly flat. There is no doubt that this bone is in process of development, for the terminal edge is very thick and truncated.

Macleayius australiensis.

Macleayius australiensis, Gray, Cat. Seals and Whales, p. 105, figs. 10 and 11 ; p. 371, figs. 74 and 75, from Krefft's photographs. Suppl. Cat. Seals and Whales, p. 46. Synopsis of Whales and Dolphins, p. 2.

Inhabits Australian seas (Krefft) ; coast of New Zealand (Haast).

Skeleton in the British Museum.

ART. XVIII.—*Notes on Dr. Hector's Paper on the Whales and Dolphins of the New Zealand Seas.**

By J. E. GRAY, Ph.D., F.R.S., Hon.Mem.N.Z.Inst.

[*Read before the Wellington Philosophical Society, 6th August,* 1873.]

THIS paper contains many most valuable observations, and adds considerably to our former knowledge of the *Cetacea* of the southern regions, as shown in the appended list. It is very interesting as confirming the existence of the genera *Grampus* and *Beluga* in the Southern or Antarctic seas. It is accompanied by tracings of the skull of *Epiodon chathamiensis*, of the lower jaw of *Mesoplodon layardi*, the ear-bones (represented half the natural size) of *Neobalæna marginata*, *Megaptera ?*, *Berardius arnouxi*, and *B. hectori*.

1. *Neobalæna marginata*.

The discovery that the baleen named *Balæna marginata*, and that the ear bones upon which I first established the genus *Caperea*, belong to this whale, is entirely due to Dr. Hector, and I gladly accept the correction, although it has always appeared to me that the baleen is very narrow and long for a whale with such a broad upper jaw, compared with that of the Northern Right Whale; but that may be a peculiarity of the group. The combination of the characters thus brought together indicates an entirely new group of whales, which I propose to call *Neobalænidæ*. The form of the skull and ear bones is peculiar, and very different from that of any known group of *Cetacea*, and I have always found that the characters derived from these parts are connected with peculiar modifications of the external form. The removal of the ear-bone of *Neobalæna* from the family *Balænidæ*, makes the character from that bone in that family as uniform as it is in the other families of *Balænoidea*. The form and structure of the whalebone is finer, but very similar to that of the Greenland Right Whale, and shows an affinity of this family to the *Balænidæ*, but the structure of the head is more like that of *Physalidæ*, as far as we can judge from the figure, never having had an opportunity of seeing the skull itself. The dilated character of the lower jaw is peculiar, and, no doubt, characteristic. The face, or rather the maxillæ and intermaxillæ, are broad for a whale having such long and slender baleen.

We await the discovery and description of the complete *Neobalæna* with great anxiety. If it is the Sulphur-bottom, or Fin-fish, it will be even more interesting, as removing that often mentioned, and hitherto undetermined, whale from our books.

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* The paper referred to appeared in the Ann. and Mag. Nat. Hist. for Feb., 1873, and has since been incorporated with Art. XIX., Vol. V., Trans. N.Z. Inst.

The synonyma will, therefore, run thus :—

Balæna marginata, Gray, Zool. Erebus and Terror, p. 48, t. 1, f. 1 (baleen only).

Caperea antipodarum, Gray, P.Z.S., 1864, p. 202, fig. ; Cat. Seals and Whales, p. 101, fig. 9 (ear-bone only) ; Cat. Suppl. (part only).

Neobalæna marginata, Gray, Ann. and Mag. Nat. Hist., 1870, V., p. 221 ; VI., p. 155, figs. 1 and 2 ; Suppl. Cat., p. 40, f. 1 and 2 (drawing of skull only).

I applied the name of *antipodarum* to this species, believing it to be the Black Whale of New Zealand, of which Dr. Dieffenbach had brought such an accurate figure ; and I was confirmed in thinking it the same as the skeleton from New Zealand, which was in the Paris Museum, by the observations of M. Milne-Edwards, Professor Lilljeborg, and Van Beneden, who, though the skeleton had lost its ear-bones, seemed to feel no doubt that it was the skeleton of the whale the ear-bones of which I figured. I have never seen the skeleton myself, for when I was in Paris they considered it a duplicate of the one they had set up, and not worth my seeing. I think it better to retain the name of *Neobalæna* for this genus. The genus *Caperea*, though first established on the ear-bone of this genus, has had its character enlarged by the study of the Paris skeleton, and it would produce less change of name to retain *Caperea* for the whale the skeleton of which is at Paris, otherwise we should have to form a new name for that genus ; but, doubtless, some person wishing to append his name to a new-named old genus, will give it a new appellation.

As the specimen in the Paris Museum has lost its ear-bones, M. Van Beneden has added to the figure of that skeleton the figure of some ear-bones said to come from New Zealand, in the Belgian Museum. Now, as there are at least two Black, or Right Whales, with very different shoulder-blades, that inhabit the coasts of New Zealand, it is not possible to say to which of these species the specimens figured by M. Van Beneden belong.

2. *Eubalæna australis.*

There are at least two Black Whales in New Zealand, and, as yet, I have no evidence that the *Eubalæna australis* has been taken in New Zealand seas. It is doubtful to which of the two Right Whales the animal figured by Dr. Dieffenbach really belongs. I applied to that figure the name of *Balæna antipodarum* (Dieffenb. New Zeal., t. 1), and *Balæna antarctica* (Voy. Erebus and Terror, t. 1); but as this has been applied to the skeleton of the New Zealand whale in the Paris Museum, by M. Milne-Edwards, Professor Lilljeborg, myself, and M. Van Beneden in the Ost. Cétacés, I believe it will be better to retain it for that species ; the form of the blade-bone, which is different from that of all the other Right Whales known, is not likely to be connected with a change in the external form of the animal.

The synonyma will run thus :—

Balæna antipodarum, Gray, Dieffenb. New Zeal., t. 1 (animal).

Balæna antarctica, Gray, Zool. Erebus and Terror, Cet. 16, t. 1 (animal, not Lesson or Owen).

Caperea antipodarum, Lilljeborg ; Gray, Cat. Seals and Whales, p. 371 ; Suppl., p. 45 (not ear-bones).

Balæna antipodarum, Van Beneden, Ostéogr. Cét., p. 46, t. 3 (skeleton; ear-bones doubtful).

The second Black Whale is *Macleayius australiensis*, a skeleton of which is in the British Museum, noticed in the Ann. and Mag. Nat. Hist., 1873, p. 75, and which is described and will be published in the Proc. Zool. Soc. for 1873. It was sent from the coast of Canterbury, New Zealand, as *Balæna antipodarum*, by Dr. Haast. I first thought, from the similarity of the ear-bones, that it was the *Eubalæna australis*, but it is extremely different from it. An account of this skeleton is sent to the New Zealand Institute.*

3. *Megaptera novæ-zelandiæ.*

The whale stranded at Wellington harbour, with "a falcate dorsal," is most probably a *Physalus*, for the peculiar character of *Megaptera* is to have merely a hunch instead of a dorsal fin, and elongate pectoral fins. The ear-bones of *Megaptera* and *Physalus* are nearly similar, and, therefore, it is most probably *Physalus antarcticus*. The colour of the baleen may vary, as the whalers say its character and texture are very different, so distinct that a dealer in these articles can distinguish the baleen of the Finners of the different countries, and they fetch different prices.

8. *Electra clancula*, Gray.

I do not know what Dr. Hector's remark refers to. Perhaps it does not refer to my description. I published a description and figure, which Dr. Hector sent to me, in the Ann. and Mag. Nat. Hist., 1872, ix., p. 436, fig.

10. *Grampus richardsoni.*

The number of teeth varies in the different specimens of the European species.

13. *Epiodon chathamiensis*, and

14. *Mesoplodon layardi.*

I have not seen the skull of *Epiodon australis*, but as yet I have never seen a species of whale or seal common to the coasts of South America and New Zealand. It may be different with the Cape of Good Hope and Australia and New Zealand, but I have seen no decided instance of the same species occurring in two countries ; therefore I can give no decided opinion respecting the jaw of *Mesoplodon layardi*. At the same time, I may observe, the

* Vide ante Art. XVII.

Mesoplodon layardi (or, as I should call it, *Dolichodon layardi*) has a much longer and more attenuated lower jaw, and much more slender teeth than the Chatham Island specimen figured and described by Dr. Hector under that name; and I have very little doubt in my own mind that the Chatham Island specimen will be found, when more perfect specimens are obtained, to be the representative of a very distinct species of *Dolichodon*, which I would propose provisionally to designate as *Dolichodon traversii*—a curious comment on the comparative anatomists, who think that *Dolichodon layardi* of the Cape, *Callidon güntheri* of New South Wales, *Petrorhynchus capensis* of the Cape, etc., etc., "all differ in so trifling a degree as not to exceed the range of individual variations one often meets with in comparing a series of skulls of the same species." Surely the author means domestic animals, and entirely leaves out of the question the experience gained by the study of wild ones, and the evidence afforded by the study of their geographical distribution. I must think that when these authors become more experienced they will wish their observations to have a "tacit burial and oblivion," and perhaps, themselves learn how to define genera and species.

15. *Berardius hectori.*

I know nothing of this skull but from the figures and description of Dr. Hector, and the skull has never been in England, so that I do not think that any comparative anatomist has had the opportunity of seeing it. Dr. Hector considered it the young of *B. arnouxi*. I at once saw that it was different, but as it has the teeth in the front of the jaw, like *Berardius*, I considered it best (and am still of the same opinion) to retain it in that genus, with which it agrees in the position of its teeth as developed in the adult animal, and in geographical distribution; and your tracings of the ear-bones of the two species show that there is a great affinity between them in the very peculiar manner in which they are dotted. I consider the position of the teeth a more important zoological character than a slight difference in the "conformation of the naso-premaxillary region," a part that, as every zoologist who has examined several skulls of different ages in the same species of Cetacea knows, is very apt to vary; but when a comparative anatomist draws his conclusions from figures on the examination of a single specimen of a group, he is often liable to be misled as to the value of the characters to which he attaches much importance. Nothing showed this better than the published results of the labours of a comparative anatomist, who has named, but not defined, a multitude of species and genera from fragments of fossil bones, but who, when he attempted to name recent skulls, as of crocodiles, of which he has perfect specimens under his eyes, named and described and published what we now regard as three distinct species in one case, and two distinct species in another, under the same name; and, on the other hand, a series of skulls of

the same species under three different names (see Trans. Zool. Soc., VI., 1869, p. 127), and who mixes up together, under one name, the skulls of two such large and distinct animals, as a one-horned and two-horned rhinoceros, under a single name, as a double-horned one. (See P.Z.S., 1867, p. 1015.) I need not, but could, refer to many more instances of the same kind. I am in the habit of estimating from what is written about what I know, the reliance I may place upon what is written of what I do not know, and have thus lost my confidence in this author's writings on zoological questions. He may be an admirable comparative anatomist, and I am told that since he has had the well-determined skeletons of the Zoological Department in the British Museum so easy of access, he does not make the mistakes that he formerly did, and his observations on the recent Ziphioid Whales are all made on skulls which I had previously determined and named.

It is an old complaint that persons will write about what they have a limited knowledge of. Thus the comparative anatomists are always giving their opinions on the limits and definitions of genera and names that ought to be used—subjects not much in their way, and on which they have very crude ideas. What would they say if a zoologist interfered with their anatomical details, their confused nomenclature of bones, and their much controverted homologies? But it is the more remarkable when we consider how very few animals have been dissected, and how imperfectly those that have been dissected have been described, as is proved by their own papers (see for instance Mr. Clarke's late paper on the hippopotamus, Proc. Zool. Soc. 1872, p. 185), that an anatomist should leave his subject and diverge to write upon the synonyma of species and the priority of names, all of which is mere compilation on his part.

ART. XIX.—*On the Occurrence of a New Species of* Euphysetes (E. pottsii), *a remarkably small Catodont Whale, on the Coast of New Zealand.*

By JULIUS HAAST, Ph.D., F.R.S., Director of the Canterbury Museum.

Plate XV.

[*Read before the Philosophical Institute of Canterbury, 6th August,* 1873.]

AMONGST the specimens lately added to the collections in the Canterbury Museum, either new to science, or at least to New Zealand, none is more interesting than that of a remarkably small catodont whale, allied to *Euphysetes grayii*, which was stranded amongst the rocks in Governor Bay, near Ohinitahi, the residence of T. H. Potts, Esq., F.L.S., by whom it was secured and presented to the Canterbury Museum.

As far as I am aware only another species of the genus *Euphysetes* exists,

in the Australian Museum, obtained in 1851 in Port Jackson, of which a description was given in Walls' History of the New Sperm Whale, 1851, 8vo, T. 2, p. 37 (skeleton), but which, according to Krefft, was entirely written by the eminent zoologist W. Sharpe MacLeay (see British Museum Catalogue of Seals and Whales, page 218, and seq.).

The specimen under review was found by some fishermen amongst the rocks, on the 17th August of this year, when it tried in vain to regain the sea, but was easily secured.

As Mr. Potts was kind enough to send immediately a telegram from Lyttelton, the taxidermist of the Museum, Mr. F. R. Fuller, could at once proceed to the spot, by which not only all necessary measurements were secured before the animal was cut into for procuring the oil, but also both skin and skeleton were obtained in perfect order.

The animal on examination proved to be a female, apparently full grown, and had the following dimensions :—

Total length	...	7 feet	2 inches.
Breadth of tail	...	1 „	4·5 „
Around body behind pectoral fins	...	4 „	2·5 „
„ „ „ eye ...	...	3 „	3 „
„ „ before dorsal fin ...	...	3 „	10 „
Pectoral fin—length ...	...	0 „	9 „
„ „ breadth ...	...	0 „	3·75 „

Colour—black, belly greyish white.

There is only one single valve covering the blow-holes, the slit being 2 inches long, of which 1·5 inches lie on the left and ·5 inch on the right side of the top of the head. The skin surrounding the valve is raised in a lunate form, rather conspicuously on the left side, open posteriorly. The left side of the valve is far more developed and stronger than the right one. The animal, however, was unfortunately too much disfigured on the top of the head, by blows or other causes, so that it was impossible to ascertain if the small channel of the right blow-hole had an opening of its own, so that it could throw out a separate jet of water, or, what is more likely, could only add a minute quantity to the main jet thrown out by the left blow-hole, of which more anon. The form of the dorsal fin could also not be well ascertained, as the hind edge, which is described by MacLeay as nearly perpendicular and concave, had, in our specimen, been torn away previously, the wound being well scarred.

The small eyes situated so low down the broad head, the pectoral fins of such inconsiderable size, the small mouth being placed like that of a shark, well back, give to this animal a strange appearance.

When first examining the anatomical characters of the skull, it at once became evident that if not identical with *Euphysetes grayii*, it would be closely allied to it.

SKELETON OF EUPHYSETES POTTSII, Haast.

1/9 nat. size.

J.B. Lith.

	Inches.
Entire length of cranium	13·5
Greatest breadth of cranium at parietal region ...	11·2
Beak from notch—length	5·2
„ breadth at notch	6·1
Length of beak at occipital bone	5·5
Breadth „ „ „	6·8

From these measurements it will be seen that the beak is shorter than broad, but not quite so much truncated and blunt as Gray's whale.

However, the most characteristic feature in the skull is the non-symmetry of the bones, which make it appear at first sight that we have a remarkable case of deformity before us. MacLeay has given a masterly description of those anomalies, and has shown how, by the great development of some bones, such as the right intermaxillary, and by the stunted form of others, these striking contortions are brought about, by which that remarkable asymmetry is caused, to which I can add nothing, as his description agrees entirely with our New Zealand skull.

The blow-holes are exceedingly disproportionate in size, the right one being scarcely the tenth part of an inch in diameter, whilst the left is nearly fifteen times as large, of an oblong form, being 1·5 inch long and 1·12 inch broad. The rami of the lower jaw are very thin and fragile, and have, like Gray's whale, scarcely any condyles. It agrees also with the latter, except in the position of the teeth, having thirteen on each side, which are described by MacLeay as projecting horizontally and being curved upwards. In the New Zealand species they have the same slender conical form, but stand out sideways with their points curved inward, the last tooth on each side, however, being curved forward, its hook nearly touching the preceding one. The two first teeth on each side stand nearly perpendicularly to the jaw, whilst the rest incline slightly backward, with the exception of the last tooth, which has again a perpendicular position. All these teeth fit into sockets on both sides of the roof of the mouth provided for their reception in the gums. However, these minor deviations would not constitute such a specific difference as to separate it from the Australian species, did not the rest of the skeleton present such marked differences.

MacLeay states that Gray's *Euphysetes* has 52 vertebræ, but I find that there must be some mistake in the enumeration of the different forms of vertebræ, because, when added, they only amount to 51, viz. :—7 cervical, 14 dorsal, 9 lumbar, 21 caudal, of which 13 have chevron bones attached—51 together.

The number of the vertebræ of the New Zealand *Euphysetes* is one less, namely, 50 ; moreover, they are differently arranged. Its 7 cervical vertebræ

are soldered together, and have all the peculiar characteristics of the Australian species, whilst it has only 12 dorsal (instead of 14), 11 lumbar (instead of 9), and 20 caudals with 8 chevron bones attached (instead of 21).

The Australian species has 14 ribs, whilst the New Zealand species has only 12, of which the first one is broad and flat, and has, like the 2nd, 3rd, 4th, 5th, and 6th, two articulating surfaces; whilst, according to MacLeay, the Australian species has only one articulating surface on the first rib. The second rib still exhibits a considerable breadth, whilst the succeeding ones become gradually narrower. The last six ribs, which assume a rounded shape, possess only one articulating surface.

Thus, even supposing that the minor differences in the form of the skull might, perhaps, be due to sex, the number, arrangement, and the form of the vertebræ and ribs alone would prove the distinct specific character of the New Zealand specimen, for which, therefore, I wish to propose the specific name of *Euphysetes pottsii*, in honour of T. H. Potts, Esq., F.L.S., by whom the specimen was secured to science.

The contents of the stomach consisted of a dark slimy matter, from which no clue could be obtained as to the usual food of the species under review; but we may conclude, from the absence of the horny beaks of Cephalopods, of which some years ago we obtained nearly half a bushel in the stomach of *Berardius arnouxii*, that this species does not feed on them. Moreover, the position and smallness of the mouth shows that this animal is probably a ground-feeder, existing, perhaps, on the smaller hydroid Zoophytes.

Before concluding I wish to draw once more your attention to the remarkable non-symmetry of the cranium of this new whale, which, probably more than any other known catodont cetacean, shows this so conspicuously. We are so accustomed to observe—almost invariably in the skeletons of the vertebrates—a perfect bilateral symmetry, that any deviation from this rule is generally regarded, if not as a monstrosity, at least as a deformity. It is, therefore, very striking to find in a whole and important cetacean section—the Denticete—the upper surface of the skull, with very few exceptions, unsymmetrical, amongst which the family of the *Catodontidæ* is the most conspicuous. This family, amongst other characteristics, is distinguished by the nostrils being enormously disproportionate in size, the left one being the largest; at the same time the nasal bones, as those of the face, are generally unsymmetrical and distorted. Of them the genus *Euphysetes* may be said to possess this unsymmetrical distortion of the skull and the difference in the size of the nostrils in the highest degree.

Systematic zoologists have generally hitherto had little time to do more than fix the so-called generic and specific characters, without being able to examine into the causes why certain animals exhibit such peculiar forms and

colours, and why their skeletons have assumed the distinct morphological characteristics by which they are distinguished from all others.

We can understand that the use or disuse of certain limbs of an organism may develope them to a more or less degree, or stunt their growth, and by which other portions of the skeleton will in their turn become differentiated.

Thus, to give only one instance, the disuse of the wings of the Kakapo (*Stringops habroptilus*) has also altered the form of the sternum, which has such a very prominent keel in the whole Parrot tribe, to such an extent that it is only feebly marked; but in this case, as in most others, the symmetry of the skeleton is not interfered with.

In some other cases, as for instance in the *Pleuronectidæ*, or Flatfishes, we can easily trace the asymmetry of their skeleton to adaptation, viz.: to their mode of obtaining food, and at the same time preserving themselves from their enemies. If, in the struggle for existence, they had not, in the course of ages, assumed their present form they would have doubtless long become extinct. Moreover, we know that the Flatfishes are symmetrical in the young state, and as they grow older the skull not only becomes distorted, but one eye actually crosses gradually from one side to the other to take its place close to the other eye.

However, in the instance of the toothed whales, at least at first sight, such vital considerations do not appear to exist, as the blow-holes, or naso-palatine breathing passages, situated on the very top of the head—by which the Cetaceans have to expose only a very small portion of their body when they rise to the surface for expelling the pulmonary discharge of used-up air, by which the spout is generally formed, and for oxygenizing again the blood by inhaling a great quantity of atmospheric air—do not receive more protection by being so remarkably unequal in size. Moreover, it appears to me that an animal would breathe as freely and effectually if the blow-holes were of equal size, of course always provided that the quantity of air to be inhaled, and of the pulmonary vapour to be expelled, found the same amount of room for passing to and fro. Thus, in the skull of the *Epiodon chathamiensis*—described by Hector,* and of which we possess a fine skeleton in the Museum—the blow-holes, although twisted considerably to the left, are of the same size; but the asymmetry of the upper portion of the skull is produced by the right inter-maxillary bone being far more developed than the left one, and, moreover, rising as a broad ridge to the very summit of the skull, and forming there a crest of considerable size on the right side only.

Unfortunately I have not access to all the necessary works of reference to enquire if this question—as to causes, growth, and uses of asymmetry in the toothed whales—has already been treated by naturalists in the northern

* Trans. N.Z. Inst., Vol. V., p. 164.

hemisphere; but it is evident, from an examination of the drawings representing the three views of a fœtal Cachalot (*Catodon*), in the Museum of the Royal College of Surgeons, that the remarkable asymmetry exists already in that early state of existence.

On the other hand, I may ask why should the *Balænidæ* have a symmetrical skull, breathing, as they do, exactly in the same manner as the toothed whales? Eschricht, who has described the important changes which the skulls of the *Balænidæ* undergo, has shown that they are in the fœtal state quite symmetrical, although later on slight inequalities in the maxillæ are sometimes discernible.

As far as I am aware no cognizable reason can be given to account for this asymmetry in the skull of the toothed whales, and we are, therefore, almost led to assume that some of their remote ancestors were deformed by some accident, and that thus this asymmetry of the skull was inherited by their progeny to a more or less extent; because it is difficult to believe that in the struggle for existence, in the adaptation to altered circumstances and a different mode of life, this strange asymmetry could be of any vital importance.

The study of the ontogeny of this species, and of the phylogeny of the family to which it belongs, and of its extinct ancestors is, therefore, of the highest importance in considering the question of the origin of species, because every step in that direction is a clear gain to science.

It may be possible that this point has already been treated at length by some naturalists, but I am not aware that this is the case, and my wish to draw the attention of my brother naturalists in New Zealand and other countries—where an opportunity is offered by acquiring specimens of toothed whales in all stages of growth, to study this striking fact in osteology—has been my only motive for alluding here more fully to it than I should otherwise have done.

ART. XX. — *On* Cheimarrichthys fosteri, *a New Genus belonging to the New Zealand Freshwater Fishes.* By JULIUS HAAST, Ph.D., F.R.S., Director of the Canterbury Museum.

Plate XVIII.

[*Read before the Philosophical Institute of Canterbury, 4th December*, 1873.]

AMONGST a collection of fishes, consisting principally of specimens of *Galaxias brevipinnis* and *Retropinna richardsonii*, obtained by Mrs. J. C. Foster, of Sumner, during the month of March, in the Otira, where that alpine torrent leaves its picturesque gorge, I observed a few specimens, four to five inches long, which were unknown to me, and on examination were found to be new to science. They proved to belong to a genus hitherto undescribed, forming part of the *Trachinina*, the second group of the *Trachidæ*, of which, as far as I am aware, only another genus (*Aphrites*) is a freshwater fish inhabiting the rivers of South America and Tasmania, but from which the species under consideration differs materially.

Genus *Cheimarrichthys.*

Body stout; head spatuliform, broad and depressed, scaleless; opening of mouth slightly oblique, and with the upper jaw longer; eyes lateral, somewhat directed upwards; scales small ctenoid; villiform teeth in both jaws, and on the vomer.

Two separate dorsals, the first consisting of three small but strong and sharp spines, of which the third is the largest; each with a small posterior membrane, so as to prevent the spine from rising to the vertical. Ventrals jugular; pectoral rays branched. Opening of gills large.

Operculum and præoperculum entire; six branchiostegals; lateral line continuous.

CHEIMARRICHTHYS FOSTERI.

D. 3 | 19; V. 1 | 6; P. 11; A. 14.

The length of the head is one fifth of the total length (without caudal fin), which is equal to the greatest height of the body.

Eyes near the upper side of the head; diameter of eye one fourth of the head; interorbital space convex, scarcely more than the diameter of the eye. Of the soft but strong dorsal spines, the second is the longest, after which they gradually diminish; of the anal, the spines rise to the third, which is the longest, both fins being similarly developed. The anal fin begins below the fifth ray of the dorsal, and extends a little further than the former.

Scales behind the head to the beginning of the soft dorsal, and above the lateral line, very small.

Colour of head dark olive green, cheeks paler; upper portion of body above

lateral line of the same dark green shade, but as we advance from the head towards the caudal fin becoming gradually lighter; now and then vertical and somewhat indistinct bands of a darker shade extending across the lateral line; of them the last, at the base of the caudal fin, is the darkest and most conspicuous. Below lateral line pale olive green. Chin and belly white. Pectoral, caudal, and ventral fins mottled dark olive green, with a somewhat linear arrangement; dorsal and anal fins mottled dark olive green in their upper portion only.

Art. XXI.—*Notes on some New Zealand Fishes.*

By Capt. F. W. Hutton, C.M.Z.S.

Plates XVIII., XIX.

[*Read before the Wellington Philosophical Society, 22nd September,* 1873.]

30. GASTEROCHISMA MELAMPUS, Richardson.

G. melampus, Richardson, Ereb. and Terr., p. 60, pl. 37.

Two specimens of this fish were received at the Colonial Museum last June from Mr. Haldon, of Waikawa, in Otago, and, although they were not in very good condition, the following description of them will prove acceptable.

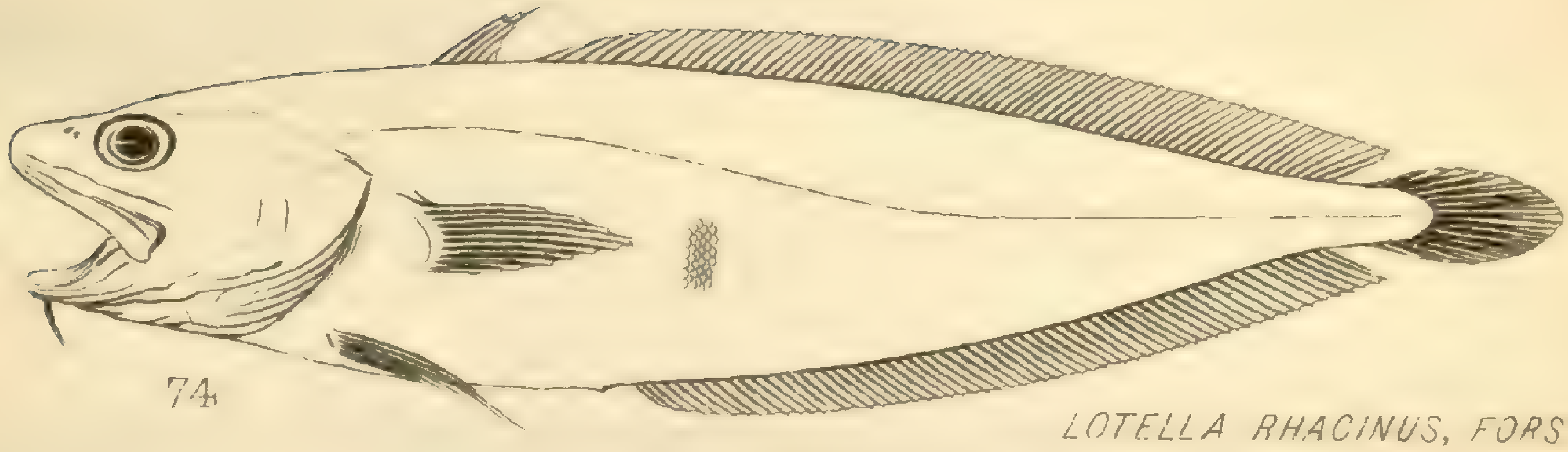
B. 4; D. 16 | $\frac{1}{9}$. VI.; A. 10. VI.; V. $\frac{1}{5}$.

Length about four times that of the head, which is equal to the height of the body; snout one third of the length of the head, and nearly twice the diameter of the eye, pointed, lower jaw longer; head compressed; opercular apparatus very weak; præoperculum not covered with skin, free posteriorly; scales moderate, delicate, deciduous, cycloid; dorsal spines nearly half as long as the head, weak; finlets broad and rounded; caudal deeply forked; ventrals one and a half times as long as the head, reaching to the anus, the rays divided to the base; pectorals less than half the length of the head.

Above steel blue, with 6–8 vertical blackish bands; below silvery; a silvery spot on the base of the caudal; dorsal and anal white; ventrals black; caudal blackish, edged outwardly with white.

Kathetostoma monopterygium (Cat. Fish. N.Z., p. 23, No. 34).

An examination of several fresh specimens of our Cat-fish has enabled me to recognize two distinct species at present confounded under this name. One of these is certainly the *Uranoscopus maculosus* of Solander, and the other is, I think, the *Uranoscopus maculatus* of Forster. The first has a filament in the mouth, while the second has not; still they are so closely related that I think it unadvisable to place them in distinct genera, and I adhere to my

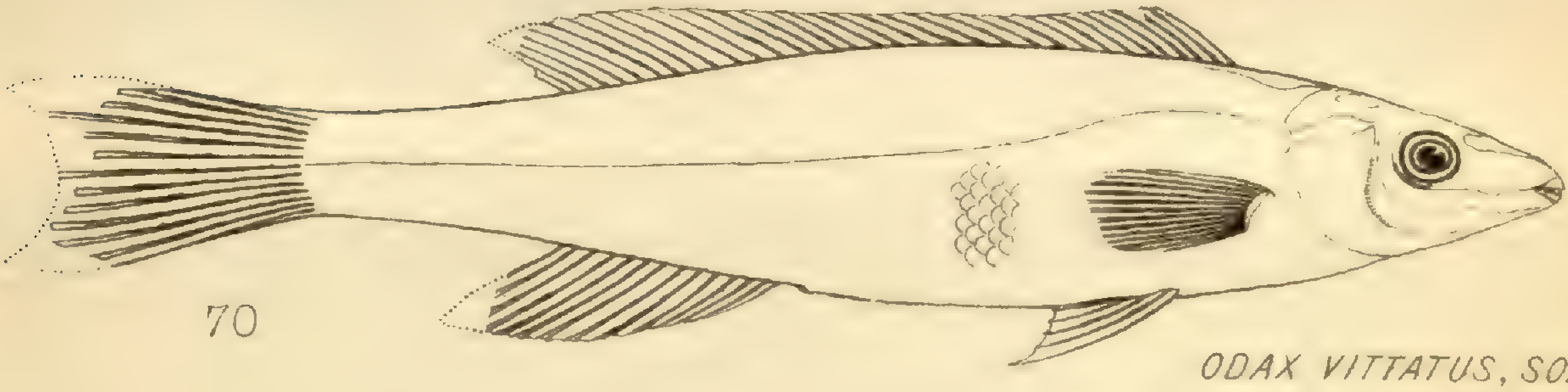


74.

LOTELLA RHACINUS, FORST.

30

GASTEROCHISMA MELAMPUS, RICH.



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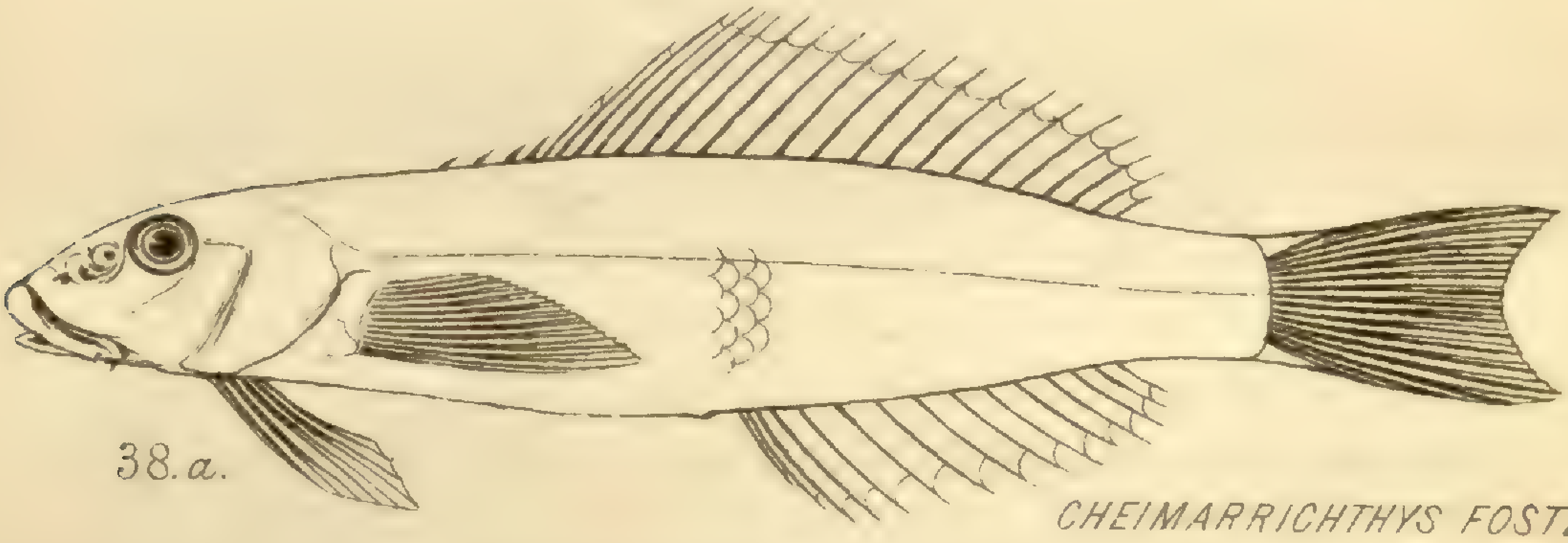
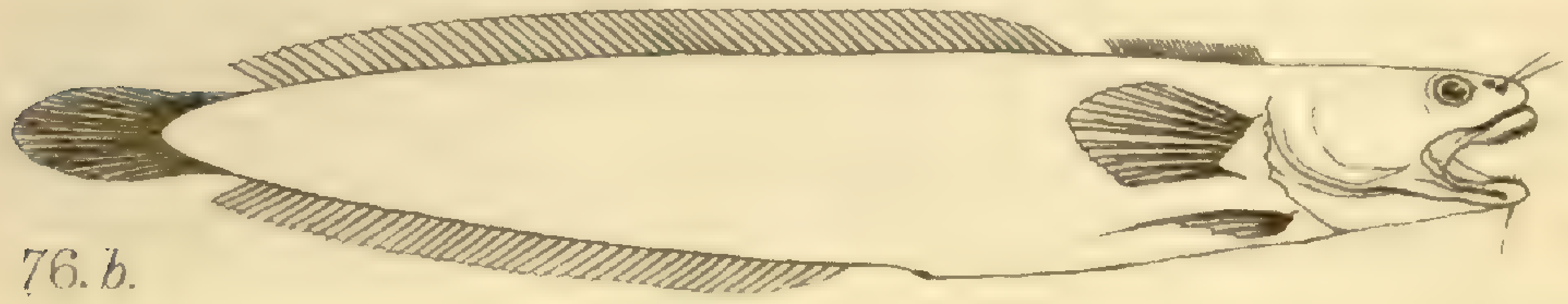
ODAX VITTATUS, SOL.



38. a.

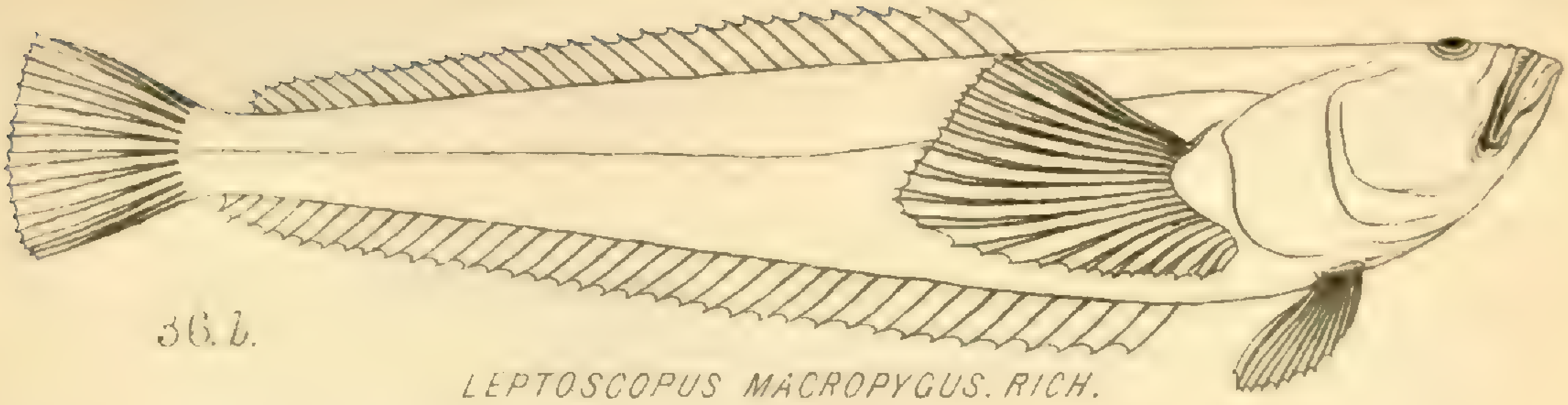
CHEIMARRICHTHYS FOSTERI, HAAST.



76. b.

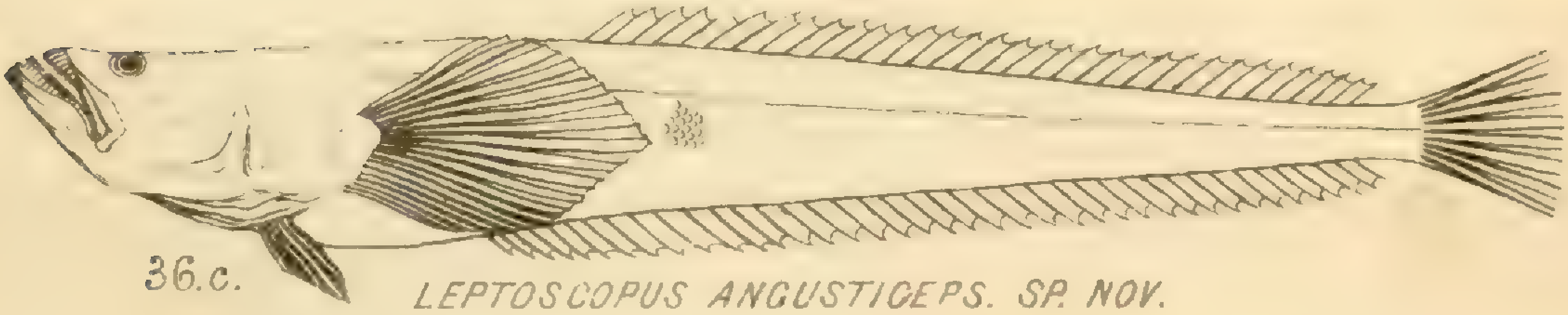
J.B. del. et lith.

MOTELLA N. ZEALANDIÆ, HECTOR.



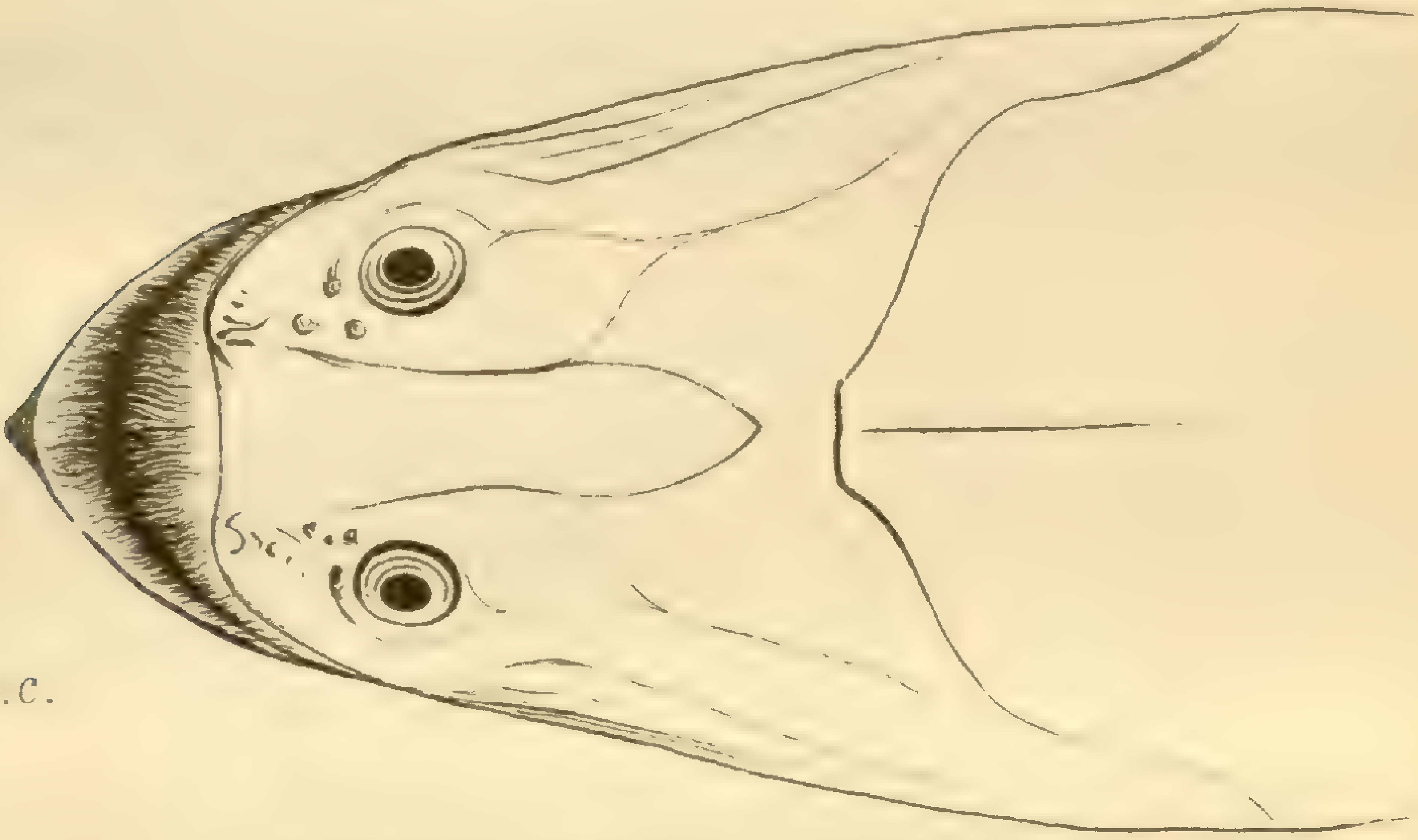
36.b.

LEPTOSCOPUS MACROPYGUS. RICH.



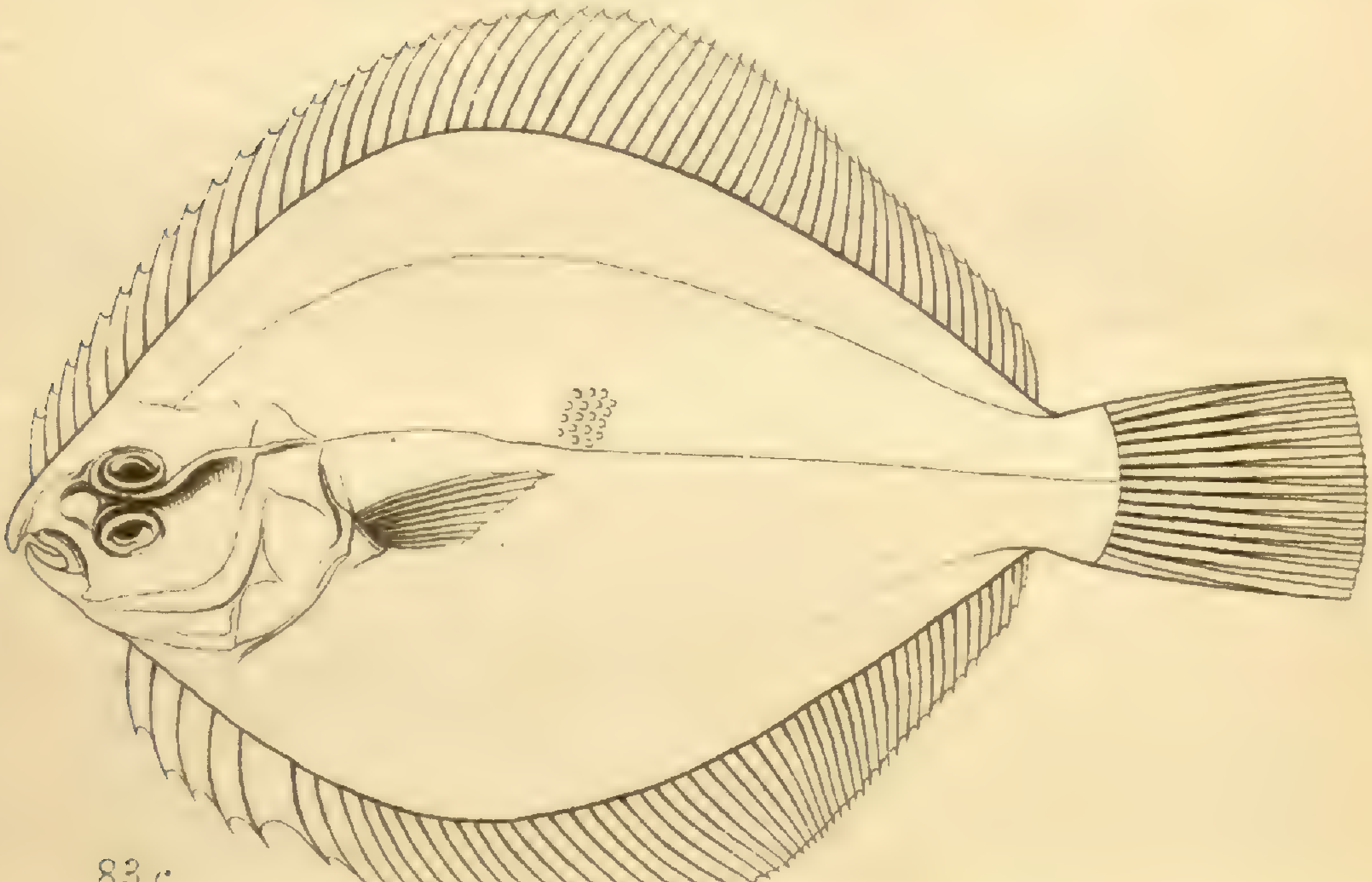
36.c.

LEPTOSCOPUS ANGUSTICEPS. SP. NOV.



36.c.

UPPER VIEW OF HEAD, NAT. SIZE.



83.c.

RHOMBOSOLEA TAPIRINA, GUNTH. (?)

J.B. del. et lith.

former opinion that it is preferable to keep them both in *Kathetostoma.* Dr. Haast has proposed (Trans. N.Z. Inst., V., p. 274) to establish another genus for the Cat-fish with a filament; but *Kathetostoma* was not separated from *Anema* by Dr. Günther on account of its having extra spines on the præoperculum, mandibula, and throat, as Dr. Haast supposes, but because it is naked, while *Anema* possesses minute scales. As, however, both our Cat-fishes have minute scales, while one has a filament in its mouth and the other has not, it seems to me impossible to keep up this distinction. The adoption of Dr. Haast's suggestion would necessitate the separation of our Cat-fish into two genera, and add a third genus, where, I think, one is sufficient. I cannot, therefore, agree with his views.

34A. KATHETOSTOMA MACULOSA.

Uranoscopus maculosus, Solander, Pisc. Austr., M.SS., p. 21 (1770). *Uranoscopus maculatus*, Richardson, Ereb. and Terr. Fishes, p. 54, pl. 33, f. 1–3, nec. *U. maculatus*, Forster.

D. 18; A. 17; P. 17; V. 5.

Length three and a quarter times that of the head, which is nine times the diameter of the eye; interorbital space twice the diameter of the eye; a filament in the mouth below the tongue.

Brown above, with large distinct pale spots on the back and sides; pectoral fins margined with white and dusky on the inside; caudal whitish, with a broad brown vertical band in the middle, and tipped with reddish.

General length 7 or 8 inches, sometimes reaching 11 inches.

The humeral and præorbital spines are sharper and more developed than in the next species, showing that it is not the young.

34B. KATHETOSTOMA MONOPTERYGIUM.

Uranoscopus maculatus, J. R. Forster, *apud* Schn., p. 49, An. 1801. *Anema monopterygium*, Günther, Cat. Fish Brit. Mus., II., p. 230.

D. 20; A. 18; P. 17; V. 5.

Length three and three quarter times that of the head, which is twelve times the diameter of the eye; interorbital space two and three quarter times the diameter of the eye; no filament in the mouth.

Brownish olivaceous above, with numerous small, often indistinct, pale spots on the back, which are larger on the sides; pectoral fins not margined with white, and the inside mottled with olivaceous and brown; caudal reddish, marbled with olivaceous brown.

General length about 16 inches, sometimes reaching 24 inches.

The granulations on the cranial plates are of quite a different character to those of the last species, and are much more obscure. The pores on the inferior margin of the præoperculum are proportionally much larger, and the

cirri on the lips, especially the upper lip, are much more developed; the lateral line also is far more difficult to distinguish.

36b. LEPTOSCOPUS MACROPYGUS, Richardson.

D. 32; A. 37; P. 19; L. lat. 90 (45); L. trans. 13 | 14.

Length three and three quarter times that of the head, or nearly six times the height of the body; head rather broader than long; interorbital space two and a half times the diameter of the eye; pectorals much shorter than the head; no humeral spine.

Upper part of the head, body, and chin olive, spotted with dark grey; lower surface, ventrals, anal, lower part of pectorals, and middle part of caudal pinkish white; upper part of tail yellowish, with large dark grey blotches; lateral line, upper part of pectorals, and upper and lower portions of caudal dark grey; præoperculum and below the chin yellowish.

A single specimen, 11 inches in length, was obtained by Dr. Hector last April in the Greymouth lagoon.

36c. LEPTOSCOPUS (?) ANGUSTICEPS, sp. nov.

B. 6; D. 33; A. 40; P. 22; L. lat. 104 (52).

Length four and a half times that of the head, or eight times the height of the body; length of the head one a half times its breadth; interorbital space less than twice the diameter of the eye; head not cuirassed, and without ridges, covered with skin; eyes on the upper angles of the head, hardly vertical; teeth in villiform bands on both jaws, and a few on the palatine bones; vomer apparently smooth; upper and lower lips with cirri; pectorals four fifths of the length of the head.

Above pale olivaceous grey, with numerous small dark grey spots, which are closer together on the top of the head; below white; a band of silvery from the chin through the opercles and the sides below the lateral line to the caudal.

Greymouth lagoon, April, 1873. Dr. Hector.

Several specimens about 13 inches in total length.

In the form of the head and the position of the eyes this species approaches *Trachinus*, but in other respects it more nearly resembles *Leptoscopus*. The lateral line is continuous, and there is no humeral spine.

83c. RHOMBOSOLEA TAPIRINA, Günther (?).

D. 65; A. 48; V. 6; P. dext. 9; sinist. 10.

Length two and a quarter times that of the head, or rather more than two and a half times the height of the body; eyes on the left side, the lower in advance; mouth narrow, the maxillary not quite reaching to the eye; small teeth in a single band on the blind side only, none on the vomer or

palate; snout a quarter the length of the head; upper jaw without a notch; cutaneous fold half as long as the snout; eyes divided by a narrow ridge; gill openings as in *R. monopus;* scales small, cycloid; lateral line straight. Dorsal and anal rays not branched; dorsal commences at the end of the cutaneous fold, and terminates at a distance from the caudal, which is contained two and a half times in the least depth of the tail; middle ray less than half the length of the head; caudal slightly rounded; left pectoral nearly three fifths the length of the head, right much shorter; one ventral, continuous with the anal; vent on the blind side.

Left side brownish, blotched with black; right side yellowish white.

This specimen agrees very well with Dr. Günther's description of *R. tapirina,* except that the eyes are on the left instead of the right side, which may be an accidental variety. The fish described by me under this name in the Trans. N.Z. Inst. (V., p. 268, 83b) evidently belongs to another species, and it can be distinguished from the present one by its small cutaneous fold, the broad interorbital space, its large and deeply sunken scales, and by its general form. It may be called *Rhombosolea retiaria.*

G. grandis, Haast. Trans. N.Z. Inst., V., p. 278.

I have examined a type specimen of this fish, sent by Dr. Haast to the Colonial Museum, and find that it agrees in every particular with *G. brevipinnis,* Günther. It is probable that the large "trout" mentioned by Dr. Hector (Cat. N.Z. Fishes, p. 124) must be also referred to this species, which is common in the rivers and lakes of the South Island, and not to *Prototroctes oxyrhynchus,* for the latter fish is found only in rapidly-running streams.

ART. XXII.—*Notice of* Motella novæ zealandiæ, *n.s.*

By JAMES HECTOR, M.D., F.R.S.

Pl. XVIII., 76 b.

[*Read before the Wellington Philosophical Society, 16th January,* 1874.]

P. 17; D. 60—58; A. 44; V. $\frac{2}{3}$.

BODY compressed; snout broad, depressed, equal in length to interorbital distance, with three barbels, two above and one beneath from lower jaw. Gape one third the length of head. Length five times that of the head, and six and a half times the height. First dorsal of minute cirri of equal length; commences at occiput. Second dorsal commences at one third the length from the snout. Post-anal portion of body one fourth longer than pre-anal. Height of dorsal uniform. Teeth in a band on both jaws, with the outer series

strongest in the upper, and the inner series strongest in the lower, and extending to only half the gape. V-shaped patch on vomer. Ventral fin with two first rays simple, second ray produced and equal in length to the head. Caudal rounded, almost continuous with the dorsal and anal. Scales minute, cycloid oblong, width being half the length. No lateral line visible. Colour, in spirit, reddish-brown, uniform, but yellowish beneath. Differs in its proportions and fin-rays from *M. pacifica*, Schleg. (Günth., IV., 367), and from *M. capensis*, Kaup, (Exp. Novara, Zool. Theil. Bd., I., 279).

Collected by Mr. Robinson, Cape Campbell, in November, 1873.

Total length seven inches.

Art. XXIII.—*On a New Genus of* Rallidæ. By Capt. F. W. Hutton.

Pl. XX., figs. 1 and 2.

[*Read before the Wellington Philosophical Society, 1st September*, 1873.]

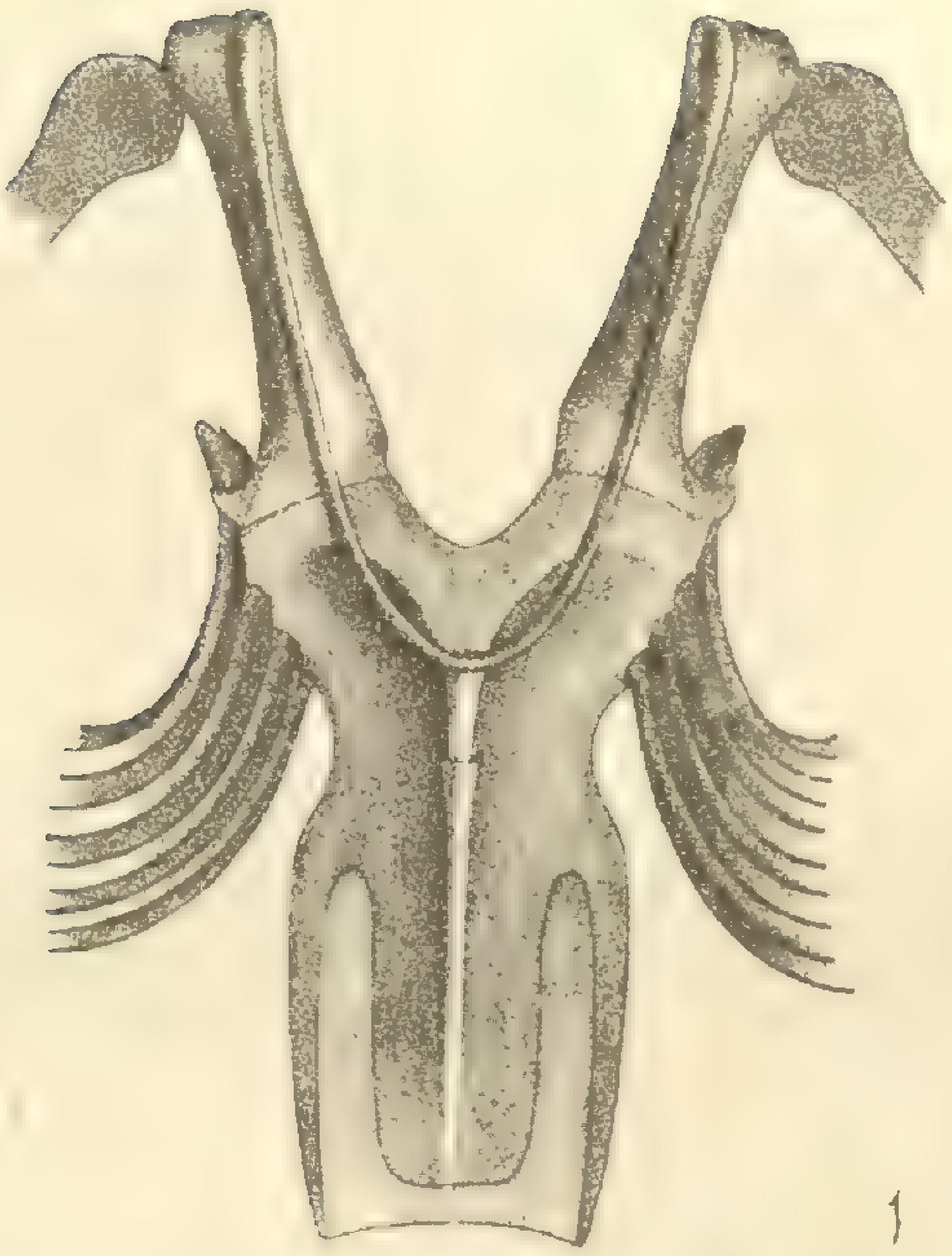
In a paper read to this Society last year I described a new species of Rail, from the Chatham Islands, under the name of *Rallus? modestus* (Trans. N.Z. Inst., V., p. 223), at the same time expressing an opinion that it would form the type of a new genus. Since then the skeleton of the other specimen obtained by Mr. H. Travers has been prepared by the late Dr. Knox, and an inspection of this skeleton has so confirmed my previous opinion that I now no longer hesitate to place it in a new genus, of which the following is a diagnosis :—

Cabalus, gen. nov.

Bill longer than the head, moderately slender and slightly curved, compressed in the middle and slightly expanding towards the tip; nostrils placed in a membranous groove which extends beyond the middle of the bill, openings exposed, oval, near the middle of the groove. Wings very short, rounded; quills soft, the outer webs as soft as the inner, fourth and fifth the longest, first nearly as long as the second; a short compressed claw at the end of the thumb. Tail very short and soft, hidden by the coverts. Tarsi moderate, shorter than the middle toe, flattened in front, and covered with transverse scales; toes long and slender, inner nearly as long as the outer; hind toe short, very slender, and placed on the inner side of the tarsus; claws short, compressed, blunt.

The bird is incapable of flight, and the stomach of the specimen dissected by Dr. Knox contained only the legs and elytra of beetles.

The skeleton is so very remarkable that I feel compelled to make a few



1

2

2/1

J.B. del. et lith.

STERNUM OF RALLUS MODESTUS.

observations on it, but without attempting any description, for doing which I have not the requisite anatomical knowledge.

The sternum (of which a front and side view, twice natural size, are given on Plate XX., figs. 1, 2) is very small and quadrangular in shape, the breadth being about ·6 of the length, but constricted below the costal border; the anterior end is deeply concave between the articular grooves for the coracoids, which are widely separated, and this concavity is smooth without any prominences or median process. The only other birds that have this remarkable concave outline of the anterior end of the sternum are, as far as I know, *Apteryx*, *Aptornis*, *Didus*, and, as Dr. Hector informs me, *Notornis*—all, it will be noticed, except *Apteryx* being extinct forms. The costal border of the sternum only forms one fifth of the lateral border, and has articulations for four sternal ribs only. The lateral processes are long and slender, commencing not far below the costal border, and in a line with the apex of the keel; they are not dilated at the ends. The keel is so much reduced as to be almost obsolete, as also is the furculum. The scapula makes a right angle with the coracoid. The pelvis is somewhat similar in shape to that of *Rallus pectoralis*, but the ilia are not expanded anteriorly, and the pelvic disc is broader in proportion behind, increasing in breadth regularly from the antacetabular portion of the ilium. The posterior outlets of the neural canal are much reduced, and the ilio-neural orifices quite obliterated. There are 9 dorsal and 12 cervical vertebræ.

The following are some of the more important dimensions:—

	Inches.
Length of sternum to the coracoid groove	·7
Breadth	·43
Height of keel	·1
Length of femur	1·2
" humerus	·95
" coracoid	·46
" scapula	·8

Dr. Buller, in his Birds of New Zealand (p. 180), says that he has no hesitation in considering my *Rallus modestus* as the young of *Rallus dieffenbachii*; but this is unquestionably a mistake. Both the birds obtained by Mr. H. Travers were full-grown, one accompanied by her young one, and the other containing well-developed ova; they were both exactly alike in colour and dimensions, in neither of which do they show any approach to the colour and dimensions of *R. dieffenbachii*, as may be seen by comparing descriptions of the two; while in all known Rails the young soon acquire a plumage approaching in colour to that of the adult, and always attain their adult plumage before breeding. In its body, tail, wings, legs and feet,

C. modestus is a smaller bird than *R. dieffenbachii*, while the bills of the two are of nearly the same length ; but in all Rails the legs and feet attain the full size very early, and long before the bill acquires its full length. *R. dieffenbachii* is also closely related in colour and form to *R. pectoralis*, while the skeleton of *C. modestus* differs largely from that of *R. pectoralis*. It is needless to pursue the subject further, but I must say that it is much to be regretted that the skin of *C. modestus*, which is one of the most curious of New Zealand birds, should have been sent to Dr. Buller, in England, on purpose that it might be figured, and that it has been returned to New Zealand with the remark that it is the young of a bird already figured in his book, and without its having been submitted to Dr. Finsch, who, as Dr. Buller is aware, is engaged on a book on the birds of New Zealand.

Art. XXIV.—*Notes on the New Zealand Wood-hens* (Ocydromus).

By Capt. F. W. Hutton, C.M.Z.S.

[*Read before the Wellington Philosophical Society, 22nd September*, 1873.]

1.—*O. troglodytes*, Gml.

The distinguishing marks of this species are its large size, the general olivaceous tint of its plumage, the middle tail-feathers having generally a black streak down the shaft, and the primary feathers of the wing tapering towards the point.

	Wing.	Tail.	Culmen.	Height of bill at base.	Tarsus.	Middle toe, without claw.
Male ...	7·8	4·8	2·0	·83	2·5	2·4
Female ...	6·7	4·4	1·7	·7	2·1	2·15

2.—*O. hectori*, sp. nov.

In size and style of colouring this bird resembles *O. troglodytes*, but its bill is more robust, its general hue is isabella brown, or fawn-coloured ; the primary feathers of the wing are rounded at the tip, and the brown bands on the webs are very narrow, sometimes becoming obsolete. The tail is coloured as in *O. troglodytes*.

	Wing.	Tail.	Culmen.	Height of bill at base.	Tarsus.	Middle toe, without claw.
Male ...	7·8	4·8	2·2	·93	2·3	2·2

This species is described from a single specimen only, and more must be obtained before we can feel sure whether it should stand as a separate species, or only as a sub-species of *O. troglodytes*. The specimen was obtained by Mr. Morton, near the Te Anau Lake, in Otago.

3.—*O. australis*, Sparrman.

Distinguished from the two former by its smaller size, the rust-red tint of its plumage, the grey colour of the throat and lower part of the breast (especially in the male bird), the more strongly marked pectoral band, and in the primary feathers of the wing tapering towards the point.

	Wing.	Tail.	Culmen.	Height of bill at base.	Tarsus.	Middle toe, without claw.
Male ...	6·5	4·4	1·7	·69	2·0	2·0
Female ...	6·7	4·4	1·8	·68	2·0	2·0

The middle tail-feathers are generally barred, but this is very variable. Except by the size, this species is not always easy to recognize from *O. troglodytes*, and it is possible that it may prove to be a variety of it.

4.—*O. fuscus*, Du Bus.

Distinguished by its dark colour, the absence of any markings on the tail, by the inner webs only of the primaries being either sparingly marked with dull ferruginous, or without spots, and by their being rounded at the point.

	Wing.	Tail.	Culmen.	Height of bill at base.	Tarsus.	Middle toe, without claw.
Male ...	7·4	4·8	2·0	·84	2·3	2·3
Female ...	6·5	4·6	2·0	·82	2·15	2·1

In the young bird the primaries are acutely pointed, and both webs are banded with ferruginous, but the bands do not extend to the shaft. The general plumage also is much lighter, the feathers being margined with yellowish ferruginous, and the tail-feathers spotted with the same colour. In this state it is not easy to distinguish from the adult of the next species. This species appears to be confined to the south coast of Otago, on the western side of the Alps.

5.—*O. finschi*, sp. nov.

Throat, abdomen, and thighs dark brownish grey; feathers of the rest of the body brownish black, with spots of yellowish ferruginous on the outer margins of each web. Under tail-coverts, and feathers of the flanks banded with yellowish ferruginous. Primary feathers of the wing acutely pointed, brownish black, banded on each web with dull ferruginous; secondaries with yellowish ferruginous spots on the margins of each web. Middle tail-feathers brownish black, the outer ones with spots of yellowish ferruginous on the margins of the webs. Bill dark brown, getting reddish towards the base of the lower mandible. Legs brownish red.

	Wing.	Tail.	Culmen.	Height of bill at base.	Tarsus.	Middle toe, without claw.
Male ...	7·7	5·0	1·9	·8	2·35	2·25
Female ...	6·35	4·6	1·7	·64	2·1	2·0

5*a*.—*Variety* or *immature*.

The light-coloured markings on the feathers larger, passing into marginal

bands. Spots on the secondaries ferruginous. Middle tail-feathers marked like the others. This species appears to be confined to the southern parts of Otago, on the eastern side of the Alps, from Te Anau Lake to the southern slopes of the Takitimu Mountains. It differs from *O. fuscus* in the markings of the wings and tail, and in the shape of the primaries. From *O. troglodytes* it differs in its general colouration, and in its smaller size. It may possibly be identical with *Gallirallus brachypterus*, Lafresnaye.

6.—*O. earli*, Gray.

Distinguished by its rusty brown back and grey abdomen. The primary feathers of the wing are, in the adult male, rounded at the point and banded with ferruginous on the inner web only; but in the adult female they are more or less banded on both webs and rounded at the tip. In the young bird they are marked as in the female, but are acutely pointed at the tip. The tail is without mark in both sexes and at all ages.

	Wing.	Tail.	Culmen.	Height of bill at base.	Tarsus.	Middle toe, without claw.
Male ...	6·6	3·9	1·8	·67	2·2	2·1
Female ...	6·0	3·25	1·8	·67	2·2	2·0

This species is confined to the North Island.

Art. XXV.—*Notes on the Ornithology of New Zealand.*

By Walter L. Buller, D.Sc., F.L.S., etc.

[*Read before the Philosophical Institute of Canterbury, 4th December*, 1873.]

The last volume of the Transactions contains an interesting paper by Dr. Otto Finsch, of Bremen, under the title of "Remarks on some Birds of New Zealand," which was read before the Philosophical Institute of Canterbury on the 5th June, 1872.*

In this paper Dr. Finsch, after mentioning an exhaustive article on the subject which he had prepared for the "Journal für Ornithologie," proceeds to state, for the information of his ornithological friends in New Zealand, "the most important facts" discovered by him before communicating them to the German periodical.

As, however, the critical remarks which Dr. Finsch has embodied in his paper appear to me to deal in many cases rather with assumptions than with "facts," and as the further discussion of debateable points may benefit science, I beg to lay before the Society the following brief notes in reply.

* Trans. N.Z. Inst., Vol. V., pp. 206—212.

Hieracidea novæ-zealandiæ, Gml.

The discussion as to the alleged distinctness of *Hieracidea novæ-zealandiæ* and *H. brunnea* has been carried a step further since the date of Dr. Finsch's paper. In the introduction to my "Birds of New Zealand" (p. 15) I have adduced further evidence in support of the view adopted in the body of the work, and it appears to me that what is now wanted to clear up the question is an extensive series of fresh specimens from different localities, carefully sexed and measured, together with further observations on their habits.

It may be mentioned that Mr. Sharpe, who contributes to the argument in a capital letter to "The Ibis" (1873, pp. 327—330), has pointed out that the name of *Falco brunneus*, of Gould, has been pre-occupied by Bechstein, who thus called the Common Kestrel of Europe, and that consequently our small bird, if allowed to be distinct from *H. novæ-zealandiæ*, must bear another title. Mr. Sharpe considers that this should be *Hieracidea australis* (Homb. et Jacq.), but it seems to me that this is only a synonym of the older species, and that the right name to fall back upon is *Falco ferox*, of Peale (U.S. Expl. Exped., 1848, p. 67).

Circus gouldi, Bonap.

I observe that Dr. Finsch adheres to the title *Circus assimilis*. This is certainly untenable, for, as first pointed out by Mr. Gurney ("Ibis," 1870, p. 536), the true *Circus assimilis* of Jardine and Selby (Ill. Orn., II., p. 51) has proved to be the young of *Circus jardinii*, figured in Gould's "Birds of Australia" (pl. 27), and the name of *C. gouldi*, proposed by Bonaparte (Consp. Gen. Av., I., p. 34), therefore stands.

Dr. Finsch says he "should like to see an old specimen, in order to prove whether this species ever assumes the dress of the old Australian bird." He will find every condition of plumage fully described at pages 11 and 12 of my "Birds of New Zealand," a perusal of which cannot fail, I think, to convince him of the identity of our bird with that inhabiting Australia and Tasmania.

Halcyon vagans, Less.

Dr. Finsch says that "having examined a large series of this Kingfisher, he considers it a good species." But it was this author himself who originally disputed its validity. He referred our bird to *Halcyon sanctus*, and was followed by Captain Hutton (Cat. Birds of N.Z., p. 3). I have always contended for its being a distinct species, and Mr. R. B. Sharpe, in his beautiful monograph on the family (published in 1870), felt no hesitation in according it that rank.

I have great respect for Dr. Finsch's judgment as a critical ornithologist, but I fear he is sometimes in danger (from the very paucity of materials at his command) of generalizing on insufficient *data*. In the present case, for

example, his decision against the recognition of *Halcyon vagans* was based "on two specimens only." His subsequent "examination of a large series" has satisfied him that his conclusions in this instance were erroneous.

Nestor esslingii, Souancè.

This "most magnificent of parrots," as Mr. Gould termed it, has finally dropped out of our list, although it held its place there as a recognized species for many years. It is one of the numerous "varieties" of *Nestor meridionalis*, of which full descriptions are given at pp. 40—45 of my book, and a very beautiful life-size drawing of it is to be found in the supplement to Gould's "Birds of Australia." I do not think it is quite fair, however, to fix upon Dr. Haast the responsibility of its retention on Dr. Finsch's previous lists. As pointed out by myself, in a paper written several years ago (Trans. N.Z. Inst., III., p. 49), the published descriptions of *Nestor esslingii* were so much at variance in their details that it was impossible to know the bird without seeing it; but I then ventured to express a belief that it would prove to be a mere variety of our highly variable *Nestor meridionalis*. This conclusion was fully verified by my examination afterwards of the type specimen in the British Museum, and I published the result in Part I. of my "Birds."

Dr. Finsch had previously enjoyed the opportunity of examining this specimen, and wrote as follows respecting it in his "Monograph" (Die Papageien):—"This species approaches, in its uniform colour, nearest to *Nestor meridionalis*, but differs from the latter satisfactorily by the broad yellowish white bands across the under part of the body, so that there can be no doubt of the specific individuality of the bird." Dr. Haast was not in any way responsible for this decision.

Prince D'Essling's bird was of unknown locality, and the mistaken reference to the species in Haast's paper (Verhandel des Zool. Bot. Ver. zu Wien, 1863, p. 116) was, of course, apparent evidence of the existence of such a bird in New-Zealand, but nothing more.

While I mention this circumstance, I must however bear testimony to the extreme care and accuracy in the determination of species which is manifest on every page of the valuable "Monograph" I have quoted.

Nestor occidentalis, Buller.

Till we know something more of this bird, the distinctness of *Nestor occidentalis* as a species must, I submit, be considered *sub judice*. No collector has since penetrated to the remote district whence Dr. Hector's specimens (now in the Colonial Museum) were obtained.

Platycercus forsteri, Finsch.

I am glad to find that Dr. Finsch has agreed to sink this species. I ventured to challenge it in 1868 (Trans. N.Z. Inst., Vol. II., p. 109); and after

examining the type in the British Museum, I pronounced it "nothing but *Pl. novæ-zealandiæ* with the red uropygial spots accidentally absent" ("Birds of New Zealand," p. 59).

Certhiparus novæ-zealandiæ, Gml.

Captain Hutton was quite right in uniting *C. maculicaudus* with this species. But Dr. Finsch was mistaken in supposing that his specimens were "from both islands," because this bird has never yet been met with in the North Island.

I examined, with the late Mr. G. R. Gray, his type of *C. maculicaudus* in the British Museum, but failed to see anything to distinguish it specifically from *C. novæ-zealandiæ.*

Rhipidura fuliginosa, Sparrm.

Dr. Finsch "hesitates to unite *R. melanura*" with the above species, because he has never met with specimens having "a white spot above the eye." There can be no doubt, I think, that both names refer to one and the same species. The white spot (not above the eye, but on the side of the head behind it) is often wanting. I have obtained specimens both with and without this feature, at the same time and consorting together, in the Round Bush, near Kaiapoi.

The interbreeding of this species with the Pied Fantail (*R. flabellifera*), as described by Mr. Potts in his admirable papers on the nesting habits of New Zealand birds, is a most interesting fact. And it is very remarkable that, whereas the pied species is universally distributed over the country, the Black Fantail is not found in the North Island, only one instance being recorded of its occurrence there ("Birds of New Zealand," p. 146).

Turnagra hectori, Buller.

I do not dispute Dr. Finsch's identification of this bird with *Keropia tanagra.* My reason, however, for retaining the specific appellation of *T. hectori* is thus stated in my "Birds of New Zealand" (p. 136):—"Under ordinary circumstances the name I have proposed would, of course, be reduced to a synonym. It will be observed, however, that Professor Schlegel has used a common generic name to distinguish the bird specifically, while he refers the form to the genus *Otagon*, established by Bonaparte in 1850. As I can see no valid reason for setting aside the generic title of *Turnagra*, proposed by Lesson as early as 1837, and as the adoption of the older specific name would, according to this view, give the confused result of *Turnagra tanagra*, I have deemed myself justified in retaining the distinctive appellation of *T. hectori.* At the same time I am anxious to give due prominence to the fact that Professor Schlegel was the first to discover the existence of this new species."

Miro longipes, Garn.

Miro albifrons, Gml.

Dr. Finsch kindly wrote to me last year, pointing out that these birds were not true *Petroicæ*, and proposed restoring them to Reichenbach's genus *Myioscopus.* Upon investigation I found that the genus *Miro*, of Lesson, had an older claim to recognition, and I accordingly substituted that for *Petroica.*

I cannot understand how Dr. Finsch could confound the two species as being "scarcely distinct." It is true that they are closely allied, but they are nevertheless so different in appearance that one specimen of *P. longipes* could be readily picked out of a hundred or more of *P. albifrons*, and *vice versâ.* The former species is confined strictly to the North Island, and the latter to the South Island.

The habits of these birds, it may be remarked, approaches very nearly to those of the true *Erythaci.*

Myiomoira toitoi, Less.

I have adopted Dr. Finsch's example in referring this and the allied species (*M. macrocephala*) to the genus defined by Reichenbach, to which they clearly belong.

Sphenœacus rufescens, Buller.

I am much surprised to find Dr. Finsch confounding this very distinct species with Gray's *Sphenœacus fulvus. S. fulvus* closely resembles *S. punctatus*, so much so in fact that I was for some time in doubt whether to keep them separate or not; and the coloured figures of *S. punctatus* and *S. rufescens*, facing page 128 of my "Birds of New Zealand," will satisfy the student, at a glance, that these are very distinct species.

The specimens in the Canterbury Museum first decided me to retain *S. fulvus*, at least provisionally, and Capt. Hutton, from an independent examination of the same specimens, appears to have arrived at a similar conclusion. (Cat. Birds of N.Z., p. 9.)

The type of *Sphenœacus fulvus* is still in the British Museum. In company with Mr. G. R. Gray, who originally distinguished the species, I made a careful comparison of it with specimens of *Sphenœacus punctatus*, and ultimately admitted it into my work, but without attempting to figure it. I still look upon it as a doubtful species, and had Dr. Finsch proposed uniting this form (instead of *S. rufescens*) to *S. punctatus*, there would have been some show of reason for it.

Creadion carunculatus, Gml.

It was not the "examination of the types by Capt. Hutton" that proved my *C. cinereus* to be the young of this species, but the examination by myself

of a fine series of specimens in the Canterbury Museum, showing the transitional changes of plumage.

I communicated the result to Capt. Hutton long before the appearance of his "Catalogue," and the descriptive notes which I made at the time will be found at page 149 of my "Birds of New Zealand."

I confess, however, that the subject is still beset with some difficulty in my own mind. Supposing the plumage of *C. cinereus* to be the first year's dress of *C. carunculatus*, it seems to me quite inexplicable that the bird has never been met with in that state in the North Island. Capt. Hutton suggests that this is due to the comparative scarcity of the species at the North. But during several years' residence in the Province of Wellington I obtained probably upwards of fifty specimens, at various times, without ever detecting any sign of this immature condition of plumage.

Admitting the comparative scarcity of the species, one would naturally suppose that the younger birds would be more likely to fall into the collector's hands than the fully adult ones. It may be suggested whether the condition of the Canterbury Museum specimens has not possibly resulted from inter-crossing; for we have not heard of any further examples being obtained. At any rate, till a specimen in the supposed immature dress has actually been taken in the North Island, the point cannot, I think, be considered finally set at rest.

In Dr. Dieffenbach's Report to the New Zealand Company, which appears in the twelfth Report of the Directors (April, 1844), I find the following mention of this species:—"Amongst the thrushes I must name, first, the Tierawaki, with two yellow appendages at the angle of its mouth, of the form and dimensions of a cucumber seed. This bird is of the size of a blackbird, with beak and feet similar to those parts in the latter. Its plumage is a glossy black; the cover-feathers of its wing and its back are of a fine red brown. I saw a variety, or perhaps another species, with plumage of variable shades of sepia."

Aplonis obscurus, Du Bus.

Both this species and *Aplonis zealandicus* (Gray) were omitted in my work, as I could not find the smallest evidence of the type specimens having come from New Zealand.

Rallus philippensis, Linn.

I entirely concur with Dr. Finsch regarding the wide geographic range of this species, the plumage being too variable to admit of the recognition of several local species, as some naturalists have suggested. But I cannot think that he is justified in retaining M. Lesson's name of *Rallus pectoralis*.

Allowing that the varieties that have been brought from Polynesia proper,

Celebes, the Navigators, the Caroline Islands, New Caledonia, the Philippine Islands, and New Zealand, are referable to one and the same species, we are bound, it seems to me, to adopt the older name of *R. philippensis*, Linn. (Syst. Nat., i., p. 263).

Hydrochelidon leucoptera, Temm.

I believe Capt. Hutton is right in his identification of Mr. Monro's specimen in the Colonial Museum, although Dr. Finsch thinks he has confounded it with *H. hybrida*, Pall. Almost immediately after my arrival in England I had an opportunity of examining a fine series of these birds in the collection of Mr. Howard Saunders, and having at that time a very distinct recollection of the New Zealand specimens, I satisfied myself that they were the same.

Eudyptes pachyrhynchus, Gray.

I have treated this in my work as a synonym of *Eudyptes chrysocomus.*

Apteryx mantelli, Bartl.

Dr. Finsch states that "after careful and repeated examination" of several specimens from both islands, he is unable to admit *Apteryx mantelli* (of the North Island) to the rank of a distinct species; but he proposes to distinguish it from the South Island form as "*Apteryx australis* var. *mantelli*, Bartl." This opens up again the old *quæstio vexata*, "what is a species?"

The amount of difference necessary to constitute a "species," in the generally accepted sense, is not capable of definition, and must ever remain, to a certain extent, a matter of opinion with each individual naturalist.

I have already stated fully my reasons for keeping the two forms specifically distinct ("Birds of New Zealand," pp. 366—367); and it is sufficient for my argument that Dr. Finsch recognizes constant characters in the North Island bird of a kind to distinguish it as a permanent "variety."

I may add that I had the satisfaction of submitting good specimens of *Apteryx australis* and *Ap. mantelli* to Professor Newton, Dr. Sclater, Mr. Salvin, and Mr. Sharpe, all of whom were decidedly of opinion that the characters relied on were of sufficient importance to warrant the separation of the species.

ART. XXVI.—*Notes on the Little Bittern of New Zealand* (Ardetta maculata). By WALTER L. BULLER, D.Sc., F.L.S., etc.

Plate XXI.

[*Received by the Wellington Philosophical Society, March*, 1874.]*

THE first mention of the existence of a Little Bittern in New Zealand was made by Mr. Ellman (Zoologist, 1861, p. 7469), who gave it a place in his list of species, apparently on native authority.

The first recorded specimens (two in number) were obtained by Mr. Shaw, at Kanieri, on the West Coast, in March, 1868, and forwarded to the Canterbury Museum, where they are still preserved. Mention of these was made in my notes on Dr. Finsch's paper, read before the Philosophical Society of Wellington, in August, 1868 (Trans. N.Z. Inst., 1868, Vol. I., p. 110).

Subsequently a third specimen was obtained "in one of the swampy creeks that feed the Okarito Lagoon," and another at the head of the Wakatipu Lake, above Queenstown, in the Province of Otago. The last-named specimen was described in a paper read before the Otago Institute, by Mr. Purdie, who proposed to name it *Ardeola novæ-zealandiæ* (Trans. N.Z. Inst., 1870, Vol. III., p. 99.) Mr. Potts afterwards referred the species to *Ardetta pusilla*, of Gould, and contributed to the Philosophical Institute of Canterbury some very interesting notes on its range and habits (Trans. N.Z. Inst., 1870, Vol. III., pp. 97—100.) In the "Birds of New Zealand" I have since given the historical synonomy, and shown that the title of *maculata* (Latham, 1801) has the oldest claim to recognition.

During a visit to Hokitika in the autumn of 1871, I received from Mr. Clapcott the skin of a fine male specimen, apparently in full adult plumage; and I afterwards secured, through the kind assistance of Dr. Garland, a second specimen (a younger male), both of which had been obtained in the vicinity of the township.

So far as I am aware, those I have enumerated are the only examples of this bird that are at present known, and none of these correspond to Mr. Gould's description of the adult female in Australia. If I recollect aright, one of the specimens in the Canterbury Museum is marked ♀, and if the sex in this case was determined by dissection, I think it highly probable that our Little Bittern will prove to be distinct from *A. maculata* of authors.

As the species is evidently very rare in New Zealand, and may, ere long, become extinct, I am anxious to direct attention to the subject without delay, in the hope that some colonist who has the opportunity will investigate this point, and so enable us to decide finally whether our bird is in reality identical with that inhabiting Australia.

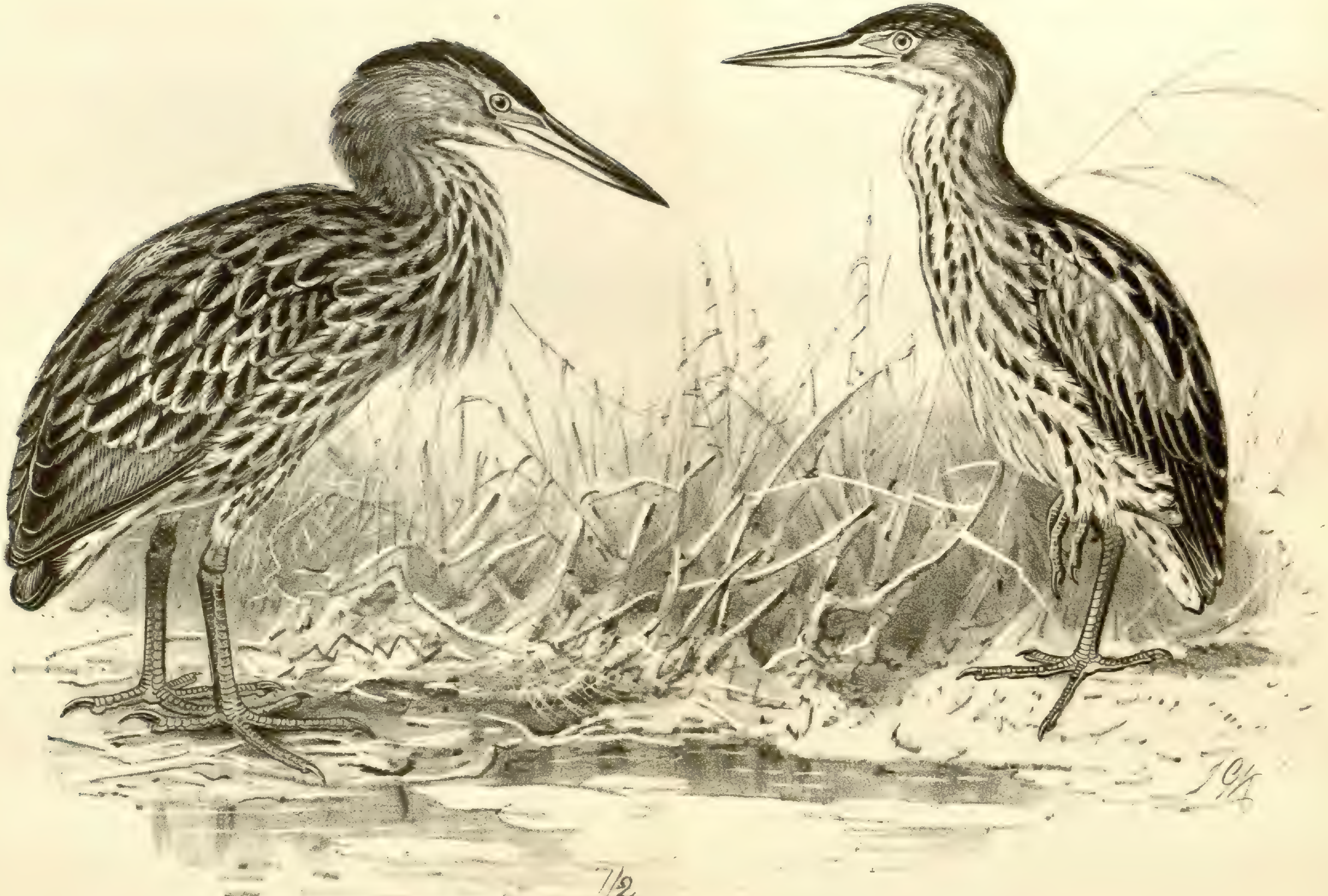
* Dated at London 30th December, 1873.

With this view I beg to lay before the Society a sketch, by Keulemans, of the two specimens which I brought to England, together with my already published descriptions.

Adult male.—Forehead, crown of the head, and nape bluish black; throat and front of the neck tawny buff, each feather shaded in the centre with brown; from the chin and down the foreneck an irregular streak of reddish brown; on the sides of the neck the buff passes gradually into a rich chestnut; and this colour is continued on the sides of the head, forming a broad streak over the eyes, and another, less distinct, to the angles of the mouth, mixed with tawny yellow on the ear-coverts; under parts pale buff, each feather centred more or less with black; on each side of the chest the black predominates, forming broad acuminate stripes; the whole of the back and the feathers composing the mantle bronzy black, tinged more or less with chestnut, the scapulars margined with tawny buff; quills and tail feathers bluish black, slaty on their under surface, the inner primaries, as well as their coverts and most of their secondaries, tipped with chestnut brown; the primary coverts and a patch of feathers near the flexure pale chestnut edged with fulvous, the former centred more or less with black; the small wing-coverts and the whole of the secondary coverts blackish brown, broadly edged with yellowish buff, and presenting a handsome appearance. Irides golden yellow; eyelids and bare space in front of the eyes yellowish green; bill dark brown along the ridge and at the tip, yellowish green on the sides and towards the base of both mandibles; legs and feet bright green, stained at the tarsal joint and along the toes with dark brown. Length 15 inches; wing, from flexure, 6·25; tail, 2; bill, along the ridge 2·2, along the edge of lower mandible 2·75; bare tibia ·5; tarsus 2·1; middle toe and claw 2·5; hind toe and claw 1·5.

Young male.—Differs from the adult in having the plumage of the back darker, and the wing-coverts of a rich tawny buff, shading into chestnut on the secondary coverts and towards the flexure.

Remarks.—Mr. Gould, in his account of this species in Australia, states that the "sexes differ considerably from each other, the female being mottled and of a smaller size than the male;" and he gives the following description of the former:—"Head and back chestnut; wing-coverts very deep tawny, passing into chestnut on the tips of the coverts and secondaries; primaries grey, tipped with brown; tail black; sides of the neck pale chestnut; front of the throat and the under surface white, with a stripe of tawny down the middle, and a small streak of brown in the centre of each feather, the brown hue predominating and forming a conspicuous mark down the throat." No specimen has yet been obtained in New Zealand answering to the above account. The young bird, from which I have taken my description, exhibits one or two new feathers among the wing-coverts, marked as in the adult with



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Adult male.

ARDETTA MACULATA.

Young male.

a broad central streak of blackish brown, thus indicating a transition to the more variegated plumage; and Dr. Garland, who dissected the specimen, informs me that it proved to be a male.

There is no specimen of *Ardetta maculata* in the British Museum; and Mr. Gould informs me that his only examples of the bird were sent with the rest of his Australian collection to America many years ago. I have not, therefore, had any opportunity of investigating the subject further in this country.

ART. XXVII.—*Note on* Platycercus unicolor *in the British Museum.*

By WALTER L. BULLER, D.Sc., F.L.S., etc.

(With Illustrations.)

[*Received by the Wellington Philosophical Society, March,* 1874.]*

ON my first visit, in company with the late Mr. G. R. Gray, to the fine collection of Parrakeets in the galleries of the British Museum, a mounted specimen standing on the same shelf with *Platycercus novæ-zealandiæ* and *P. auriceps* immediately arrested my attention. My companion informed me that this was the type of *Platycercus unicolor* (Vigors), and that it was supposed to have come from New Zealand. On further enquiry I found that the bird had come to the Museum from the Zoological Society's Gardens, where it had lived for some time; that its origin was unknown, and that the specimen was quite unique. It will be seen, therefore, that there is no authority for regarding it as a New Zealand bird; although, from the close relation it bears to *P. novæ-zealandiæ*, it may, I think, be fairly inferred that it belongs to the same zoological province, and is an inhabitant of some part of Polynesia. It must be borne in mind that our *P. novæ-zealandiæ* is not confined to New Zealand, but spreads over about thirty-two degrees of latitude, the range of the species extending from Macquarrie Island (lat. 55° S.) to New Caledonia (lat. 23° S.).

My present object in bringing the species before the notice of the Society is to prevent its being again confounded with *Platycercus novæ-zealandiæ*, from which it is unquestionably distinct. In my "Further Notes on the Ornithology of New Zealand," published in a former volume of the "Transactions" (Trans. N.Z. Inst., Vol. III., pp. 37—56), I stated that Dr. Finsch's supposition of its being the ordinary young state of *P. novæ-zealandiæ* was entirely incorrect; but I expressed, at the same time, a belief

* Dated at London 30th December, 1873.

that it would turn out to be an accidental variety of the common species. An examination of the type specimen satisfied me at once that it was a good species, very readily distinguishable from *P. novæ-zealandiæ* by its more robust form and more powerful mandibles, independently of its uniform green colour.

The accompanying sketch of the heads of the two species (natural size) will sufficiently confirm what I have said.

FIG. 1.—*P. novæ-zealandiæ*. FIG. 2.—*P. unicolor*.

Mr. G. R. Gray included this species in his List of the Birds of New Zealand ("Ibis," 1862), and on this authority, although rejected by me in the "Essay" (Trans. N.Z. Inst., Vol. I., 1868), it has been retained on most of the subsequent lists.

As the original description by Vigors* is not very accessible, and as the account of the bird in Dr. Finsch's excellent Monograph ("Die Papageien," p. 289) does not appear to bring out the distinctive characters, as compared with *P. novæ-zealandiæ*, with sufficient clearness, I venture to characterize the species as follows :—

PLATYCERCUS UNICOLOR, *Vig.*

Diag.—Omnino prasinus, vertice capitisque lateribus lætioribus : dorso et

* Proc. Zool. Soc., 1831, p. 24.

corpore subtûs flavido lavatis: alâ spuriâ et primariis exterioribus extûs cyanescentibus: caudâ sordidè viridi, subtûs flavicanti-brunneâ—rostro nigro, versus basin albido—pedibus brunnescentibus.

Adult.—General plumage grass green, brighter on the crown, sides of the head, face, and ear-coverts; back, rump, and all the under surface strongly tinged with yellow; primaries bright green on their outer vanes; the margins of the outermost primaries, as well as their coverts and the whole of the bastard quills, indigo blue; tail-feathers dull green, olivaceous or yellowish brown on their under surface. Bill black, greyish white towards the base of lower mandible; legs and feet dull brown.

Comparative Measurements.

	P. unicolor.	*P. novæ-zealandiæ.*
Extreme length ...	13·25 inches ...	11·25 inches
Wing from flexure ...	6 „ ...	5·25 „
Tail	6·25 „ ...	6 „
Culmen	1·25 „ ...	·8 „
Tarsus	·9 „ ...	·8 „
Longer fore toe and claw	1·4 „ ...	1·15 „
Longer hind toe and claw	1·25 „ ...	1 „

Art. XXVIII.—*Remarks on Captain Hutton's Notes on Certain Species of New Zealand Birds.*—By Walter L. Buller, D.Sc., F.L.S., etc.

(With Illustrations.)

[*Received by the Wellington Philosophical Society, March,* 1874.]*

Gerygone flaviventris, *Gray.*

In a paper which I had the honour of reading before the Society in November, 1870 (Trans. N.Z. Inst., Vol. III., pp. 37—56), I referred at some length to the nest-building habits of *Gerygone flaviventris*, and in the course of my observations I made the following remark:—

"Among the substances used as building materials by this bird, spiders' nests are always conspicuous; indeed, in some specimens the whole exterior surface is covered with them. The particular web chosen for this purpose is an adhesive cocoon of loose texture, and of a dull green colour. These

* Dated at London 26th December, 1873.

spiders' nests contain a cluster of flesh-coloured eggs, or young, and in tearing them off the bird necessarily exposes the contents, which it eagerly devours. Thus, while engaged in collecting the necessary building material, it finds also a plentiful supply of food—an economy of time and labor very necessary to a bird that requires to build a nest fully ten times its own size, and to rear a foster-brood of hungry cuckoos in addition to its own" (*l.c.*, p. 42).

This statement appearing, I suppose, fanciful to Captain Hutton, he ventured, in the "Critical Notes" appended to his Catalogue of New Zealand Birds (p. 73), to pronounce these spiders' webs nothing but fresh-water Algæ! Captain Hutton afterwards wrote to me, admitting his error, but I cannot find that he has made any avowal of it in his numerous communications to the Institute. This omission is, I think, to be regretted; for while it is perfectly well understood that the "opinions" of a writer on any question of science are a fair subject of criticism and discussion, one naturalist has no right to impugn the accuracy of another in matters of fact, or to throw doubt on his habits of observation, unless in doing so he can adduce something better that mere conjecture.

Rallus modestus, *Hutton.*

The October number of "The Ibis" contains a communication from Captain Hutton in defence of this species. He combats my judgment in referring his type specimen to *Rallus dieffenbachii*, juv. ("Birds of New Zealand," p. 180), and enters upon a long argument to prove that not only are they distinct species, but that they belong to different sub-genera. Inasmuch, however, as there is a fatal mistake in Captain Hutton's premises, his conclusions go for nothing.

"I labour under the difficulty of never having seen the specimen of *Rallus dieffenbachii*" is the admission with which he starts, and he immediately falls into the error of supposing that it is scarcely distinguishable from *Rallus philippensis*, "in fact [to quote his own words] so similar are they that it appears to me doubtful whether *R. dieffenbachii* should be retained as a distinct species." Starting, therefore, with the assumption that *Rallus diffenbachii* and *R. philippensis* are the same—in which he is entirely wrong—he proceeds to prove that *Rallus modestus* "belongs to a different sub-genus from *Rallus philippensis.*" He gives a figure to show that "the bill of *R. modestus* is much more slender and longer in proportion to the size of the bird than in *R. philippensis,*" and indicates other points of difference.

Granting the whole of his argument as regards *Rallus philippensis,* that is quite beside the question of *Rallus modestus* and *R. dieffenbachii* being the same, which is the only point in issue.

Let the reader glance at the subjoined figures (by Keulemans) of the heads

of *Rallus philippensis* and *Rallus dieffenbachii*, and then compare them with the figure Captain Hutton has given of the head of *Rallus modestus.*

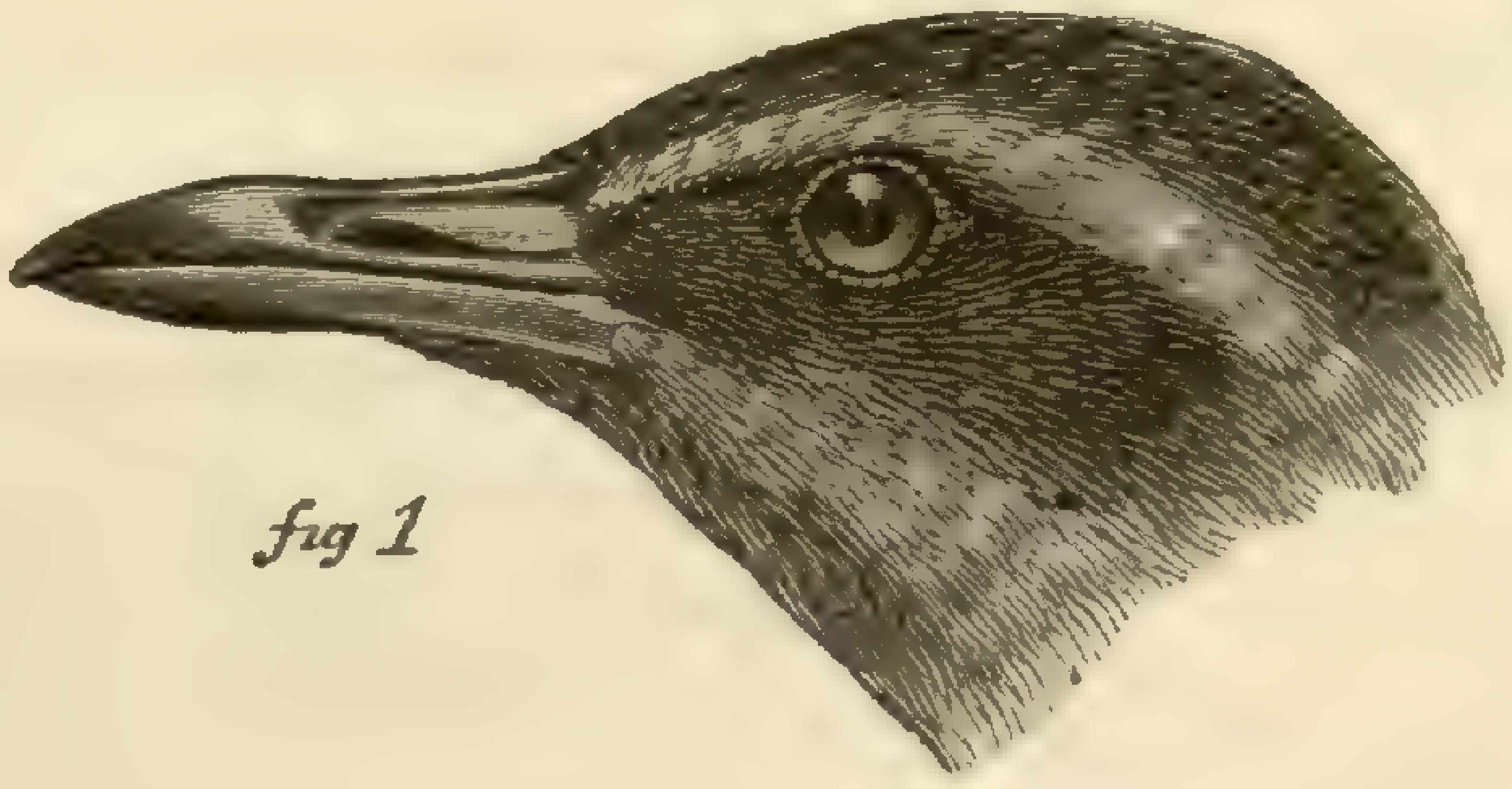


FIG. 1.—*R. philippensis.* FIG. 2.—*R. dieffenbachii.*

It will, I think, be at once manifest that what Captain Hutton says of the bill of *Rallus modestus*, as compared with *R. philippensis*, applies with equal force to that of *R. dieffenbachii.*

No two species of Rail, I should say, are more readily distinguishable than *Rallus philippensis* and *R. dieffenbachii.* I have rejected sub-generic distinctions altogether in my work, or I would willingly have referred these forms to different sub-genera, as was originally proposed by the late Mr. G. R. Gray. No naturalist who had actually seen the birds would attempt to unite them as a species.

The fallacy of Captain Hutton's case is, that he labours to disprove a proposition of his own making, for no one ever asserted that *Rallus philippensis* and *Rallus modestus* were the same.

Captain Hutton is in error in stating that "*R. philippensis* has no claw at the end of the thumb." The claw is well developed and very sharp. [The specimen submitted measures ·25 of an inch in length.]

TRIBONYX MORTIERI, *Du Bus.*

The introduction to my "Birds of New Zealand" contains a notice of the occurrence in Otago of a living example of *Tribonyx mortieri.* But from Captain Hutton's letter to "The Ibis" of 1st July last, it would seem that the bird brought home by Mr. Bills was obtained at Hobart Town, and kept for

a time in the Otago Acclimatization Society's Gardens, and that (as is too often the case) a wilful deception was practised by the dealer for the sake of obtaining a higher price.

The bird in question was purchased from Mr. Bills by the Zoological Society *as a New Zealand bird*, and I received a letter from Dr. Sclater apprising me of the fact, and kindly placing it at my service. Mr. Bills, whom I saw personally on the subject, declared that it had been obtained on the shores of Lake Waihora, in the interior of the Otago Province, and gave me a circumstantial account of its capture ! As there was nothing improbable in the occurrence of such a form in New Zealand, or rather (as I have pointed out in my Introduction, p. xviii.) as such a form might naturally be looked for there, I did not, of course, discredit the story, and was only too glad to accept Dr. Sclater's offer to make use of the Society's wood-cut in my notice of the species.

Art. XXIX.—*Notes by Captain Hutton on Dr. Buller's "Birds of New Zealand," with the Author's Replies thereto.**

[*Received by the Wellington Philosophical Society, March,* 1874.]†

"Although fully recognizing the value to ornithologists of Dr. Buller's handsome work on the birds of New Zealand, especially in his determination of *Thinornis rossii* as the young of *T. novæ-zealandiæ*, and in his identification of *Gallinago pusilla* with *G. aucklandica*, I wish to point out what I consider to be certain inaccuracies that I have noticed in it, and also to record my dissent from some of the opinions expressed therein.

"I have in these notes followed Dr. Buller's nomenclature, but I do not agree with it in all cases."

[When I undertook to write a "History" of the birds of New Zealand, I was not insensible to the difficulties of the task. The field was a comparatively unbroken one, and, with a few notable exceptions, the existing literature was confined to dry lists of names and characters of species. In the preparation of my work I had, therefore, to rely mainly on the results of my own observations, extending over a period of many years. At the same time, I freely availed myself of the assistance of Mr. Potts and other local observers, whose contributions were, in every instance, duly acknowledged. Having produced a royal quarto volume of some 400 pages, the bulk of it being purely original matter, it was not to be expected that my statements on every point would pass unchallenged, or that naturalists who think for themselves would

* See "The Ibis," January, 1874. † Dated at London 26th December, 1873.

endorse all my views. Besides, as I have explained in my preface, our present knowledge of many of the rarer species is confessedly imperfect, while in regard to all of them some new fact is being constantly added to the general stock of information. The notes and corrections of impartial observers in New Zealand will be very valuable to me, as they will assist in making a future edition of my work more exhaustive and complete. The first contribution of this kind is Captain Hutton's paper, which appeared in the last number of "The Ibis." But, in attempting to correct my inaccuracies, Captain Hutton appears to have fallen into many errors himself.]

"SCELOGLAUX ALBIFACIES.

"I cannot agree with Dr. Buller's remark that 'the extinction of the native rat has been followed by the almost total disappearance of this singular bird,' nor with the conclusion that he draws from it; for I have elsewhere pointed out (Trans. N. Z. Inst. V., p. 230) that there is no evidence that an indigenous rat ever existed in this country; and supposing even that there had been a 'native rat,' it could only have been exterminated by other rats and mice taking its place. There is also no evidence to show that the Laughing Owl was formerly 'more plentiful than it now is,' or that it has now almost totally disappeared. During a short tour of six weeks through the Nelson Province last summer, I twice heard it, once at Fox Hill, and again on the river Conway.

"Besides its laugh it has a peculiar note, like two branches of a tree rubbing together, repeated twice over at considerable intervals.

"Its laugh is very different from that of the bird that I heard on the Little Barrier Island (Trans. N.Z. Inst. I., p. 162), which I think must be of another species."

[Capt. Hutton states that there is no evidence to show that the Laughing Owl was formerly more plentiful than it now is, or that it has almost totally disappeared. Of the former fact I have abundant evidence in the accounts given by the Maoris. As to its present scarcity, it may be sufficient to state that I have never heard of more than a dozen specimens, and have never seen but one living example. Capt. Hutton does not state that he has ever met with the bird outside of a museum; and the peculiar sound, "like two branches of a tree rubbing together," which he has so often heard in the forest, may, I think, be accounted for in a very simple manner.]

"STRINGOPS HABROPTILUS.

"Dr. Buller's mistake in supposing that the superficial analogy of the facial disk of this bird to that of an Owl, as well as the softness of its plumage and its nocturnal habits, seem 'to prove that it supplies in the grand scheme of nature the connecting link between the Owls and Parrots,' has been already

pointed out (Ann. Nat. Hist., 1872, p. 477), so that I have only to record my total dissent from Dr. Buller's views. Dr. Buller also states that this 'bird is known to be a ground-feeder, with a voracious appetite, and to subsist chiefly on mosses.' That it may sometimes eat moss is probable; but I have tried in vain to induce it to do so in captivity, and one that escaped in a garden in Auckland remained for a fortnight in a clump of pine trees feeding on the flowers, and was never seen to descend to the ground. He also states that 'there is no physiological reason why the Kakapo should not be as good a flier as any other Parrot.' I should have thought that the small pectoral muscles, almost total absence of keel on the sternum, and soft primary feathers of the wing, were quite sufficient physiological reasons."

[Captain Hutton ought to have quoted the whole of the sentence, for I stated that "in all the essential characteristics of structure it is a true Parrot." My statement that this species subsists chiefly on mosses rests on the authority of Dr. Haast, who has collected and dissected far more specimens than any other person in the colony, and whose close study of the bird in its native haunts is sufficiently manifest from the paper which appeared in "The Ibis" (1864, pp. 340—346). Captain Hutton does not inform us what particular kind of moss he offered in vain to his captive bird. My statement that "there is no physiological reason why the Kakapo should not be as good a flier as any other Parrot," must of course be read with the context. My argument was, that *disuse*, under the usual operation of the laws of nature, had, in process of time, occasioned this physical disability of wing.]

"NESTOR OCCIDENTALIS.

"I agree with Dr. Finsch that this species must be united with *N. meridionalis.*"

[I am very doubtful myself about this species, and Dr. Finsch may, therefore, be right in uniting it to *Nestor meridionalis.* (See my remarks "Birds of New Zealand," p. 50.) I have in my possession, however, a note from Captain Hutton, declaring himself in favour of *N. occidentalis* as a species distinguishable from *N. meridionalis* "by having the upper mandible more compressed and flat on both sides, with the tooth further out, and the lower mandible not reaching it."

For my own part, I attach very little importance to these variations in the character of the bill, for that member is more or less variable in all the members of the genus *Nestor.*]

"HETERALOCHA ACUTIROSTRIS.

"The tongue of this bird is not, according to my observations, 'bifurcate at the tip,' nor is it 'furnished with minute barbs,' but is deeply fringed at the tip, and slightly so down each side for about a third of its length."

[Mr. A. H. Garrod, in his exhaustive account of the anatomy of this bird (Proc. Zool. Soc., 1872, pp. 643—7), states that the tongue is "slightly bifid at its apex, and a little prolonged backwards at its lateral borders."]

"HALCYON VAGANS.

"I have never known an instance of this bird catching fish; like the rest of the genus it subsists entirely on insects and crustaceans."

[Captain Hutton is quite mistaken on this point. I have myself observed our bird catching fish in the manner described; and Mr. Potts, who is known to be a very accurate observer, states that "fish and crustacea furnish some portion of its food supply" (Trans. N.Z. Inst., 1869, Vol. II., p. 53). Nor do "the rest of the genus subsist entirely on insects and crustaceans." Dr. Jerdon states that *Halcyon smyrnensis* catches fish, "for which it sometimes dives," and that *Halcyon pileata* "feeds both on fish and insects." *Halcyon gularis* is said to be a fish-eater; and Mr. Motley declares that *Halcyon coromanda* "subsists entirely on fish." Dr. von Heugtin states that *Halcyon semicærulea* is "more of a fish-eater than fond of Orthoptera," and that *Halcyon chloris* likewise habitually fishes. To come nearer home, I may add that Mr. E. P. Ramsay, of Sydney, records that he has watched *Halcyon sanctus* "catching flies from the surface of the water, and occasionally a stray fish or two."]

"PROSTHEMADERA NOVÆ-ZEALANDIÆ.

"The bird described and figured as young must surely be a variety. I have seen several young specimens, but none of them had a white crescent on the throat."

[The young figured in my work is from a specimen in the British Museum. My artist has somewhat exaggerated the white, and given it too much of a crescent form. I must refer the reader to my description of the young ("Birds of New Zealand," p. 88), where this feature is specially mentioned.]

"ANTHORNIS MELANURA.

"Dr. Buller is certainly in error in saying that this bird is dying out all over New Zealand, for it is one of the commonest of birds in the South Island, and can be seen in almost every garden. The district in which it is all but exterminated corresponds far better with the district thickly inhabited by Maoris than with the district thickly inhabited by *Mus decumanus.* I have never observed any bright-coloured feathers in its nest."

[The extensive wooded district lying between Whangarei and the North Cape is not inhabited by Maoris at all, and Captain Hutton's argument therefore fails. Dr. Hector, who made a geological survey of this district in 1868, did not meet with a single *Anthornis*, whereas formerly these birds existed there in thousands! As Captain Hutton has "never observed any bright-

coloured feathers," he cannot, I think, have collected many nests. The observations recorded by Mr. Potts (Trans. N.Z. Inst., 1869, Vol. II., p. 56) fully accord with my own.]

"ORTHONYX ALBICILLA.

"I quite agree with Mr. Potts that this bird is by no means the representative in the North Island of *O. ochrocephala.* The structure of its feet shows that it is not an *Orthonyx* at all; and in its habit and song it is quite different from *O. ochrocephala.* According to my observations it does not prefer low bush, nor does it climb the boles of trees, but is almost always seen hopping about in the very topmost boughs of tall trees.

"Dr. Buller is also mistaken in saying that it sings like the canary. It is the robin (*Miro longipes*) that sings like the canary, while the song of the white-head (*O.* (?) *albicilla*) is much like that of the yellow-hammer (*Emberiza citrinella*), but without the last note."

[I cannot concur in the opinion expressed by Captain Hutton, for the two birds certainly belong to the same genus. I confess, however, that this form is somewhat aberrant from the typical *Orthonyx.* As to resemblance of song, that is purely a matter of fancy and association. I have never considered the song of our wood-robin (*M. longipes*) in the least degree like that of the Canary.]

"CERTHIPARUS NOVÆ-ZEALANDIÆ.

"Dr. Buller says that the egg of this bird is not known; but I described it in 1871 in my 'Catalogue of the Birds of New Zealand' from specimens that had been in the Otago Museum for several years."

[I cannot accept Captain Hutton's identification of the supposed eggs of this bird in the Otago Museum without further proof. I have already pointed out ("Birds of New Zealand," p. 105) that he had confounded this species with the very common *Orthonyx albicilla* of the North Island.]

"XENICUS LONGIPES.

"I cannot accept Dr. Buller's identification of this bird with *X. stokesii* without further proof. Dr. Buller obtained specimens of *X. stokesii* which he wrongly determined as *X. longipes;* in fact all the specimens of *X. longipes* in his collection were *X. stokesii;* these he compared with *X. stokesii* in the British Museum, and naturally found them identical. But until it is explained how it is that the figure and description of *X. longipes* in the 'Voyage of the Erebus and Terror' differ so much from specimens of *X. stokesii*, I must continue to regard them as two species.

"Dr. Buller also states that this bird is strictly arboreal in its habits, never being seen on the ground. This is quite incorrect of *X. stokesii*, which is constantly on the ground, and never ascends into high trees."

[Captain Hutton is in error in stating that the specimens of *Xenicus longipes* in my collection (Colonial Museum) were wrongly determined. There is no such species as *Xenicus stokesii.* The explanation of the strikingly incorrect figure of *X. longipes* in the "Voyage of the Erebus and Terror" will be found at page 116 of my "Birds of New Zealand." I may mention that, in company with the late Mr. G. R. Gray, I examined Foster's original (unfinished) drawing of this bird, in which the bill is depicted as straight, and the eye-circlet almost wanting. Mr. Gray told me that his artist was responsible for the alterations in the published figure (which represents a bird with an upturned bill, like *Acanthisitta*), and that his own description of the species ("Voy. Ereb. and Terr.," p. 4) was taken from the latter! After we had thus sifted the matter and compared specimens, Mr. Gray readily admitted that his *Xenicus stokesii* ("Ibis," 1862, p. 219) would not stand.]

"GERYGONE FLAVIVENTRIS.

"In the figure given of this bird the breast is white, whereas it should be grey; while in the description of *G. albofrontata* the breast is described as grey when it should have been white.

"I was in error in saying that this bird never uses spiders' nests in the construction of its nest. Dr. Powell informs me that the green spider's nest made use of is that of *Epeira verrucosa.* It is remarkable that *G. albofrontata* in the Chatham Islands uses the very same species of spider's nest as *G. flaviventris*, and neither ever employs the orange-coloured nest of *Epeira antipodiana.*"

[The fact that this species uses spiders' nests in the construction of its own nest was first mentioned by me in 1870 (Trans. N.Z. Inst., Vol. III., p. 41), and was contradicted by Captain Hutton, in his usual emphatic manner, in the Critical Notes appended to his "Catalogue." There is nothing unaccountable, as it seems to me, in the use of the green-coloured nests of *Epeira verrucosa* and the rejection of the orange-coloured nests of *E. antipodiana.* It is easily explained on the principle of assimilative or protective colouring. My description of *Gerygone albofrontata* is from the type specimen in the British Museum.]

"MIRO TRAVERSI.

"I am not aware that I ever suggested to Dr. Buller that he should call this bird after Mr. H. Travers. The facts of the case are these:—When Mr. Travers' collection of Chatham Island birds arrived at the Museum, Dr. Hector handed it over to me, with instructions to make a list of them, describe the new species, and pick out a set of the novelties to send to Dr. Buller. This I did, and described the bird as *Petroica traversi;* and, with Dr. Hector's consent, the list was sent for publication in 'The Ibis' ('Ibis,'

1872, p. 243) in order that Dr. Buller might avail himself of it in the preparation of his book. The birds sent to Dr. Buller had also my names attached to each. My list was published in 'The Ibis' in July, 1872; and I have a letter from Dr. Buller saying that the Editor had sent him a proof of my paper before the part of his book containing *M. traversi* was published. I do not think this can be considered as a *suggestion* to Dr. Buller that *he* should name this species after Mr. H. Travers."

[Captain Hutton misquotes me in a very unfair manner. I never said that he had made any "suggestion" to me about naming this bird. The specimen was kindly sent to me by Dr. Hector, without any restriction, and I might have anticipated Captain Hutton by describing it under any other name. Knowing how the case stood, however, I stated (p. 123) that I had "much pleasure in adopting Captain Hutton's proposal" to name the species in honour of the discoverer. At that time no description of the bird had been published; nor did I receive the proof of Captain Hutton's paper in "The Ibis" till after my account of *Miro traversi* had been printed off. Part II. of my work, containing this, was published in June; "The Ibis" a month later.]

"MYIOMOIRA MACROCEPHALA.

"I am still not convinced that this species is identical with *M. dieffenbachii.* The bright yellow of the breast, which characterizes the latter, is seen in the young before it is fully fledged; and the difference cannot, therefore, be due to age or to season."

[Dr. Finsch agrees with me that *Miro dieffenbachii* is not separable from *M. macrocephala.*]

"GLAUCOPIS CINEREA.

"Dr. Buller has omitted to notice the habit this bird has of holding its food in its foot when eating. Mr. W. Travers has described this in *G. cinerea* (Trans. N.Z. Inst., IV., p. 212); and I have myself observed it in *G. wilsoni. Porphyrio melanotus* has the same habit."

[Captain Hutton and Mr. Travers are quite right about the peculiar feeding habit of this bird. I frequently observed it in my captive specimen of *G. wilsoni*, but somehow omitted to record it. I have noticed this habit in *Porphyrio melanotus* ("Birds of New Zealand," p. 186).]

"CARPOPHAGA NOVÆ-ZEALANDIÆ.

"In 'The Ibis' for July, 1872, p. 246, I described two eggs supposed to belong to this bird, brought by Mr. H. Travers from the Chatham Islands. Mr. Travers has since informed me that he is not sure to what bird these eggs belong, as he found them on the ground, but supposed them to be those of the Pigeon, because in each case a pigeon was sitting in a tree above (!). The colour, however, and small size are sufficient proofs that they cannot belong to

C. novæ-zealandiæ; and when Mr. Potts saw them he at once recognized them as the eggs of a Stormy Petrel. Both Mr. H. Travers and myself now believe that they belong to *Thalassidroma fregata.*

"It is the more necessary that I should correct this mistake, as Dr. Buller, in his book (p. 160), states that the egg of *C. novæ-zealandiæ* is '1·5 inch in length by 1·1 in breadth; the surface is smooth without being glossy, and, as a rule, pure white, but sometimes marked with obscure purplish spots at the thicker end,' and, although not given as a quotation, the measurements and latter part of this description must have been taken from my paper in 'The Ibis,' as they correspond entirely with it. The egg of this bird is still a desideratum in collections."

[My description of the egg of this species was taken from one obtained by me in the Upper Manawatu many years ago. The specimen came into my hands very much broken, and as my measurements were consequently uncertain, I adopted those given by Captain Hutton as from a perfect specimen, never supposing that he could mistake the egg of a Petrel for that of a Pigeon! The addition "*sometimes* marked with obscure purplish spots," was on the same unfortunate authority; for my specimen had no spots whatever, and the natives had always described the egg to me as perfectly white.]

"OCYDROMUS EARLI.

"It is much to be regretted that Dr. Buller does not produce better evidence in support of his statement that this bird occasionally breeds with the Barn-door Fowl. It is certainly astonishing that a naturalist should see and 'carefully examine' several supposed hybrids, and never preserve specimens, nor even take an intelligible description of them, nor ascertain what these supposed hybrids developed into. Dr. Buller cannot expect that other naturalists will accept as true a statement made in such a loose and unscientific manner."

[Captain Hutton expresses astonishment at my not having preserved Dr. Hewson's specimen of the hybrid Wood-hen, and my not having ascertained what it developed into. The bird was promised to me, but unfortunately was shortly afterwards consigned to the pot; and this put an end both to the specimen and its "development." Captain Hutton quotes me incorrectly in stating that I carefully examined *several* supposed hybrids.]

"OCYDROMUS AUSTRALIS.

"The male bird described by Dr. Buller under this name is *O. troglodytes* (Gm.), while the female is the true *O. australis* (Sparrm.). These two species are quite distinct, as has been pointed out by Dr. Finsch in the 'Journal für Ornithologie,' May, 1872, p. 174, etc. Another species of this genus has been lately received at the Colonial Museum from Otago, which I shall shortly describe."

[Dr. Finsch is probably right in distinguishing a second species (*Ocydromus troglodytes*). I have myself stated ("Birds of New Zealand," p. 171) that "examples from different localities exhibit so much variety in size and plumage as to suggest the existence of another closely-allied species."]

"Charadrius fulvus.

"Dr. Buller states that this bird 'occurs occasionally on the New Zealand coast;' but as both Mr. Gould and Dr. Jerdon state that it resembles in habits the Golden Plover of Europe, this is very unlikely to be the case. He also makes no mention of the only specimen contained in any New Zealand collection, viz., that in the Auckland Museum, which was presented by Dr. Buller himself, but without any mention of the locality."

[Captain Hutton is under a wrong impression as to my having presented the specimen of *C. fulvus* which exists in the Auckland Museum. It was there as far back as 1855; and, beyond the assurance of the curator that it was a New Zealand example, I know nothing whatever about it. The species (according to Drs. Finsch and Hartlaub) is distributed over the islands of the South Pacific, and there is nothing unlikely in its occurrence in New Zealand.]

"Anarhynchus frontalis.

"I cannot follow Mr. Potts and Dr. Buller in thinking that the bent bill of this bird is useful in enabling it 'to follow up retreating insects by making the circuit of a water-worn stone with far greater ease than if it had been furnished with a straight beak.' In the first place, unless the bird is also furnished with some means of seeing round a corner, it would not be able to see the insect it wanted to catch; in the second place, the bird is just as common in the sandy bed of the Waikato, and on the mud-flats of the Manukau harbour, where there are no stones, as it is in the shingle-beds of the rivers of the South Island; and, in the third place, I have often watched the bird feeding and never yet saw it run round a stone more than any other bird might do.

"It seems to me that a bill bent on one side would be very useful to a bird whose usual food was either minute but numerous organisms, such as Diatomaceæ, etc., or small animals hidden among fine Algæ, etc.; for by slightly inclining its head it could lay a considerable part of its bill flat on the ground, and thus, in the first case, take up a much larger quantity of those minute organisms at a time, or, in the latter, could search over a greater extent of Algæ for creatures that it could not see, than if it used only the point of the bill. The broad bill of the duck performs the same office in a different manner. I by no means assert, however, that this is the use of the peculiar shape of the bill; for I have had no opportunity of observing one through a

telescope when feeding, neither have I examined the contents of the stomach to ascertain on what they feed; but it must be remembered that the curve in the bill would not prevent the bird from eating insects and other animals also."

[Captain Hutton says he has never seen this bird run round a stone in the manner described by Mr. Potts. But this is merely negative evidence. Mr. Potts describes this habit from *actual observation.* Captain Hutton's principal argument against it is, that "unless the bird is also furnished with some means of seeing round a corner, it would not be able to see the insect it wanted to catch"; but an essential part of his own theory of the use of the bent bill is, that it enables the bird "to search over a greater extent of Algæ for creatures that *it could not see,* than if it used only the point of the bill."]

"NYCTICORAX CALEDONICUS.

"Dr. Buller says that several instances have been reported of this bird occurring in the South Island; but both Dr. Haast and Mr. Fuller assure me that they never heard of it. The only authenticated New Zealand specimen appears to be the one mentioned by Dr. Buller as having been shot in the Province of Wellington sixteen years ago; but when I came to the Colonial Museum I found two or three specimens, without labels, among the New Zealand birds, and I somehow got the idea into my head that they had been obtained in the South Island: this made me state, in my 'Catalogue of the Birds of New Zealand,' that the bird was found in both islands, a mistake which has probably led Dr. Buller astray."

[Captain Hutton acknowledges that his only reason for recording this species as occurring in both islands was that he "somehow got the idea into his head." Statements made in this "loose and unscientific manner" are not very creditable to a professed naturalist. My specimen of *Nycticorax caledonicus* was obtained in the North Island, and I heard of two instances of the occurrence of this bird at Hokitika, in the South Island. This was my authority for including the species in my work; and Captain Hutton is, therefore, mistaken in supposing that his "Catalogue" had led me astray.

I did not give any particulars of locality, etc., when I handed my collection of New Zealand birds over to the Colonial Museum; but a number was affixed to each specimen, corresponding to that on my list. With Dr. Hector's concurrence, and for obvious reasons, all further information was reserved for my own work, then in course of preparation.]

"LARUS SCOPULINUS.

"The young of this bird takes a year and a half to arrive at the full colours of the adult. When one year old they lose the brown feathers of the wings and back and assume the plumage of the adult; but the red bill and legs are not got until the second spring.

"Larus bulleri.

"This bird is, no doubt, identical with *L. pomare.* It does not 'deposit its eggs on the ground,' but forms a very good nest."

[Although this bird may sometimes form a rude nest of dry bents, it usually deposits its eggs on the ground. So also does *Larus scopulinus.*]

"Diomedea melanophrys.

"Dr. Buller will find more information on the subject of Petrels flying at night in 'The Ibis' for 1867, p. 192."

[I had unfortunately overlooked Captain Hutton's paper, or would certainly have quoted it, especially as it qualifies his former statement ('Ibis,' 1865, p. 278) that *D. melanophrys* is "quite diurnal in its habits."]

"Pelecanoides urinatrix.

"This bird flies very fairly; and it is quite incorrect to describe it as 'a rapid fluttering movement along the surface of the water.'"

[Mr. Gould, in his account of this species, says that "its flight is a curious fluttering motion, performed so close to the surface that it rarely rises high enough to top the waves, but upon being met by them makes progress by a direct course through instead of over them;" and Latham states that it congregates in flocks "fluttering upon the surface of the water, or sitting upon it."]

"Puffinus brevicaudus.

"This bird is not by any means abundant on our coasts; only one specimen has as yet been obtained, which was exhibited by Dr. Buller in the New Zealand Exhibition of 1865. The nesting-places mentioned by Dr. Buller, in the Kaimanawa ranges, and in the Taupo-Patea country, are no doubt those of *Procellaria parkinsoni.*"

[My specimen was picked up on the sea beach between Waikanae and Rangitikei, where this bird is often cast ashore. The natives on that coast identified it as the same that breeds in the Kaimanawa and Taupo-Patea ranges. I can hardly think they would confound it with *Procellaria parkinsoni*, which is a very different bird.]

"Puffinus gavius.

"Dr. Buller gives *P. opisthomelas* (Coues) as a synonym of this species. In this he probably follows me, as he does not say that he has been able to compare it with any typical specimens. But this is another of my mistakes that he has unfortunately adopted without acknowledgment; for on a further examination I find that our bird always has the tail-coverts pure white, while in *P. opisthomelas* most of them are fuliginous. *P. gavius* can hardly be said to 'enjoy a wide oceanic range,' when it has never yet been found out of sight of New Zealand."

[In giving *P. opisthomelas* (Coues) as a synonym of this species, I had no wish to ignore Captain Hutton ; but it is manifestly impossible, in a list of synonyms, to do more than give the leading reference in each case. Captain Hutton has apparently forgotten that we went into the question together before I left the colony, and came to the conclusion that *P. opisthomelas* and *P. gavius* were the same. Dr. Coues states that the former species is abundant on the South Pacific coast of North America. Assuming, therefore, the identification, I was justified in assigning our bird a "wide oceanic range." To Dr. Finsch belongs the credit of having since put us right on this point. This author says (Journal für Ornithologie, 1872, p. 256):—"Hutton's account of this species, which, since Forster's time, has not been examined, appears to be perfectly correct, but he is certainly mistaken when he asserts most positively that *P. opisthomelas* (Coues) is the same species. This could only be determined by actually comparing the typical specimens, and this would clearly show a difference between the two species. Hutton's description is far too superficial to allow of anything approaching to a correct opinion." As Captain Hutton is so very sensitive about not being acknowledged, it is rather surprising that when he wrote to "The Ibis" stating he "had found out his mistake" in describing *Graucalus melanops* as *Colluricincla concinna,* he did not also state to whom that discovery was due.]

"THALASSIDROMA FREGATA.

"This species is far more plentiful in New Zealand than *T. melanogaster.*"

[My experience differs from Captain Hutton's, for I have always found *Thalassidroma melanogaster* more plentiful on our shores than *T. fregata.*]

"PROCELLARIA PARKINSONI is common all round the New Zealand coasts, and not by any means confined to the Hauraki Gulf, as Dr. Buller would seem to imply. It breeds in the Rimutaka Mountains near Wellington."

[When I left the colony all the known examples had been obtained in the Hauraki Gulf. I am aware that it has since been met with in Cook Strait, and on other parts of our coast.]

"DAPTION CAPENSIS.

"I cannot agree with Dr. Buller that the history of this bird has been fully recorded, when even its breeding-place is not yet known."

[What I meant, of course, was the known history of this familiar species, for I had nothing to add to it. It is equally common in the Atlantic and Pacific oceans, and many excellent accounts have been written of it.]

"PHALACROCORAX NOVÆ-HOLLANDIÆ.

"This bird differs from European specimens in never getting so white on the head and neck ; but this is not, in my opinion, sufficient to entitle it to

rank as a distinct species. Dr. Buller, in his quotation from my catalogue, omits the first part of the sentence, in which I say that the change in my opinion about this bird was owing to my having visited the South Island."

[I cannot see how Captain Hutton's visit to the South Island in any way affects the argument. The only question is, whether the difference of plumage (admitting it to be constant) entitles our bird to rank as a distinct species. I follow Mr. Gould in believing that it does.]

"PHALACROCORAX BREVIROSTRIS.

"According to Mr. H. Travers, this bird is not found in the Chatham Islands."

[This species certainly does occur in the Chatham Islands, for I shot a specimen there myself during a short visit in 1855.]

"PHALACROCORAX PUNCTATUS.

"The stage of plumage figured and described by Dr. Buller as that of the female is the winter dress of both sexes. The plumage of the sexes is similar in all Cormorants. This bird is quite as abundant at Napier and in the Firth of the Thames as in any part of the South Island."

[I stated ("Birds of New Zealand," p. 336) that I was "by no means certain whether this was not only a seasonal state of plumage." I cannot, however, accept Captain Hutton's dictum on this point till he gives some facts in support of it. Mr. Fuller, who has collected scores of these birds at all seasons, rejected this view, and assured me that he had found the crested and uncrested birds breeding in separate pairs at one and the same time. Both Dr. Haast and Mr. Fuller were inclined to consider the uncrested bird a distinct species.]

"APTERYX MANTELLI.

"This bird is not so scarce in the North Island as Dr. Buller imagines. In 1866 I heard it at the Waikato coal-mines; and a few months previously a surveying party killed five at Taupiri, on the opposite side of the river. The natives also told me that it was common on the Piako ranges. In 1868 I heard of four being killed at Howick, and two in the Waitakerei ranges, both places being within a few miles of Auckland; and I have on several occasions had eggs brought me from Pirongia."

[The few instances that Captain Hutton records do not suffice to make *Apteryx mantelli* a common species in the North Island. Its practical scarcity may be inferred from the fact that an offer of £5 for a specimen, which appeared some time ago in the Maori newspaper, failed to obtain one.

I must here record my total dissent from the opinion expressed by Captain Hutton, and based on the structure of the egg-shell, that *Apteryx* "belongs to the Carinate type of birds" (Trans. N.Z. Inst., IV., p. 167), for such a view is entirely opposed to the principles of modern classification.]

Art. XXX.—*On the Birds of New Zealand.* By T. H. Potts, F.L.S.

(Part IV.)

[*Read before the Philosophical Institute of Canterbury, 4th December*, 1873.]

List of Birds described in this Paper.

Note.—The species are numbered in conformity with the lists given in Parts I., II., and III., in *Trans.* N.Z. Inst., II., Art. viii.; III., Art. xi.; and V., Art. xx.

No.	
1.	Falco novæ-zealandiæ.
A. 1.	„ ferox.
3.	Athene novæ-zealandiæ.
8.	Neomorpha gouldi.
18.	Acanthisitta chloris.
19.	Orthonyx ochrocephala.
B. 19.	{ Certhiparus albicilla. Orthonyx albicillus.
23.	Gerygone.
29.	Petroica macrocephala.
36.	Keropia crassirostris.
37–8.	Rhipidura.
40.	Glaucopis cinerea.
47–50.	Platycercus.
51.	Nestor meridionalis.
57.	Eudynamis tahitiensis.
58.	Chrysococcyx lucidus.
59.	Carpophaga novæ-zealandiæ.
A. 65.	Charadrius obscurus.
B. 65.	Anarhynchus frontalis.
C. 65.	Thinornis novæ-zealandiæ.
85.	Ortygometra affinis.
86.	„ tabuensis.
A. 89.	Ocydromus fuscus.
B. 89.	Gallinago pusilla.
102.	Eudyptes.
A. 108.	Ossifraga alba.
123.	Diomedea melanophrys.
124.	Lestris catarractes.
126.	Larus dominicanus.
B. 131.	Sterna alba.

In offering another small budget of notes on native birds, the writer has to express his regret that they are but fragmentary. Unfortunately notes on birds in their wild state are necessarily less complete than those which can be gathered from the fluttering prisoners in the condemned cell of an aviary.

The writer having been laid under contribution by Dr. Buller, in his "History of the Birds of New Zealand," is compelled to refer to some mistakes as to matters of fact in the "History," or else he might be thought to concur therein; as to theories, they are the property of anyone to shape according to fancy.

No. 1.—Falco novæ-zealandiæ, *Gml.*

Quail-hawk.

Those ornithologists who have written on the fauna of New Zealand have held conflicting opinions on the *Falconidæ.* Attempts have been made to prove that one species only inhabits these islands; on the other hand, evidence has been offered that the fauna includes at least two species. The question involved—of much interest to those who care for the natural history of this country—has its chief difficulty in the absence of such marked or distinctive

characteristics of form and colour as would enable the ornithologist to recognize at once a specific difference. Messrs. Finsch, Gurney, Hutton, and Buller, have given their opinions, *pro* and *con.*, but outside the value of the evidence that may be got from the critical examination of specimens, there remains for consideration the weight that may be attached to certain peculiarities that can be learnt from the birds themselves. Are these peculiarities sufficiently marked to justify a separation of our *Falconidæ* into two species?

The three writers just named, as far as we are aware, do not touch on these birds in their living state. Dr. Buller's evidence must be sifted to ascertain its value; he deals with the living bird, and, at present, inclines towards the maintenance of two species. In Trans. N.Z. Inst., Vol. I., p. 106 (1868), he writes:—"In a paper forwarded to the Philosophical Institute of Canterbury, in June, 1864, and again in the Essay, I stated my belief that on a further acquaintance with the species it would be found necessary to expunge *Hieracidea brunnea* from our list of species, and to regard it as *H. novæ-zealandiæ* in an immature state. * * * * Since the publication of the Essay I have been able to determine satisfactorily this disputed point.

"In December last, during a visit to the Taupo district, I was fortunate enough to discover a nest of this hawk, containing three young ones. The parent birds were beautiful specimens of *H. novæ-zealandiæ*. * * * One of them shortly afterwards died, but the others (which are still alive in my aviary) developed in due time into perfect examples of the so-called *H. brunnea*. It will be seen, therefore, that this form is the young of *H. novæ-zealandiæ*, and not the female, as suggested by Herr Finsch." In striking contrast to this statement, we find his notice of the *Falconidæ* in his "History of the Birds of New Zealand;" at page 9, the story of the inmates of the nest found in the Taupo district is given as a portion of the history of *H. brunnea*. Now, will this fresh view of these nestlings induce us to rely that Dr. Buller has "been able to determine satisfactorily this disputed point"?

In the introduction to the "Birds of New Zealand," page xv., may be found this passage:—"Thus Dr. Haast writes to me (under date of March 10, 1872), concerning the specific distinctness of the Sparrow-hawk and the Quail-hawk. I may tell you that on my last journey into the interior I got two of the former (*i.e.* the small species). They were male and female, and I secured them at the nest, where they had young ones. The female was a little bigger and lighter than the male bird. Both birds were *full*-grown, and showed at a glance the impossibility of their ever developing into the large and perfectly distinct Quail-hawk." This reads like strong evidence in favour of the two-species theory, but there must be some mistake in this statement.

These two birds were shot by Mr. W. P. Phillips, then manager of the writer's cattle-station on the Upper Rangitata, whilst they were assailing the poultry close to the house. Mr. Phillips, who killed them, preserved their skins, and presented them to Dr. Haast, who did not know of a Falcon's nest, and made a guess at the sexes of these specimens. From the station journal it was ascertained they were killed on February 10th. These two Falcons are in the type collection of the Canterbury Museum, and, in the opinion of the writer, are birds in their first season. In support of the maintenance of the two-species theory, the following information is submitted. In November, 1868, two nests were found on the Lake Coleridge Ranges. The young were captured when quite small by one of Mr. Oakden's shepherds, and both families presented to the Canterbury Acclimatization Society. Mr. Oakden stated to the writer that the birds from the one nest were readily distinguishable from those of the other nest, even from the first; in size there was a marked difference, perhaps of about one-third, this contrast of size being maintained up to the time when some of the birds were shipped for export to England. The writer has seen numbers of both species, and has a series of many specimens that have been collected in the course of some twenty years. In life, besides the marked difference in size and in robustness of frame, the Sparrow-hawk (*Falco ferox*) looks flatter about the head and carries the wings more prominently forward, this carriage giving the bird a less rounded appearance than is observable in the larger species. The smaller Falcon is more savage and resolute, swifter in flight than its congener, and will soon rid a pigeon-house of its inmates.

Last December some very robust specimens of *Falco novæ-zealandiæ* were observed by the writer about the sounds of the south-west coast of this island. Those birds were observed on some occasions to pursue sea-gulls. Two females, shot in Preservation Inlet, measured as under:—

	Total length.	Wing.	Tail.	Tarsus.	Spread of wings from tip to tip.
No. 1 ...	18 inches	11 inches	7·8 inches	2·9 inches	32 inches
No. 2 ...	18 „	11·5 „	8·5 „	3·2 „	35·4 „

Their habitat, rocks and cliffs towering above the sea. From the crop of one specimen was taken the remains of a very large rat, one hind leg of which had been swallowed whole. These very robust specimens of our larger Falcon could not well be identified with the same species as the light, dashing little Sparrow-hawk (*F. ferox*).

If the cabinet ornithologist will not permit the fauna to possess two species, *Falco ferox* = *F. brunnea* must be the young state of *Falco novæ-zealandiæ*; in this case we must try to believe that the greatest boldness and audacity in attacking, the greatest activity and swiftness of wing in pursuing, is exhibited by the Quail-hawk before it has reached its adult state; neither

may we have regard to the difference of size which specimens of either sex very often present.

Near the Ashburton one of the writer's sons, Geoffrey Potts, saw a large weka (*Ocydromus*) successfully attacked by a Quail-hawk. Noticing the swoop of the Falcon, he rode up in time to pick up the weka at its last gasp; the fatal stroke had been dealt on the head and neck, from which a few feathers only had been displaced.

This hawk displays much dexterity in cutting off a single bird from a flock, whether of pigeons, kakas, or parroquets. The pursuit of each species seems to require the bird to call in aid some special method of attack; the chase after the noisy, screaming kaka, so often turning in its laboured flight to ward off the impending stroke, differing from that after the silent, strong-winged pigeon, as much, perhaps, as either varies from the pursuit of the parroquet. Perhaps the Quail-hawk shows nicety of calculation of the requisite force of its stroke, combined with the greatest neatness of execution, in surprising a king-fisher whilst perched on a telegraph wire.

We have known the newly-settled Australian magpie (*Gymnorhina*) defend itself successfully by throwing itself on its back, striking out with beak and claws, and shrieking most wildly.

No. A. 1.—Falco ferox, *Peale*.

Sparrow-hawk.

We have the egg of this bird from the Paringa River, Westland.

A nest was found up the Ashburton Gorge, on the bare ground, sheltered by a snow-grass tussock. It contained one egg partially incubated. One of the old birds was knocked over with a stone, and the flesh of the broken wing was found to be infested with parasitic worms.

December 28.—Found young birds up the Lawrence River able to fly some hundred yards or so. They were most stoutly defended by the parent birds acting in concert. With almost ceaseless swoops and with noisy screams they tried to stay our intruding steps. The young had been fed on larks (*Anthus*).

The domestic pigeon affords a fine chase for this Falcon; every nerve and muscle is strained to the utmost in the flight, the efforts of the pigeon being directed to prevent the Hawk from getting the air of it, whilst the pursuer dashes on regardless of everything but the quarry. Although the pigeon often saves its life for a time by dropping into cover, yet in the end the Hawk almost always gets the wearied pigeon.

We have known the Sparrow-hawk in the month of June (winter) pursue its prey early in the morning by the light of the waning moon.

We have approached close to the bird after a chase, and have noticed that

it has a habit sometimes of resting on one foot, drawing up the other foot to the breast, then slowly stretching out the leg, like an athlete trying his muscle.

Sometimes, when the bird just alights, or when it is perched on some weak or slender bough, the tail is held almost horizontally; when at rest we have noticed that sometimes the tail is pressed against the perch.

The writer could multiply instances of the occurrence of *F. ferox*, and give more notes of the birds it preys on, but *cui bono?* There will still be found the same uncertainty in the minds of many as to the existence of one or two species, which doubts may last till the genus is improved from off the face of the earth.

Up the Waio River, South Westland, at breeding time, these birds have been known to chase cattle dogs to the shelter of the stockman's horse.

No. 3.—Athene novæ-zealandiæ, *Gml.*

More-pork.

Some instances have been noticed where this useful bird has at intervals taken up its abode amidst men's dwellings. During the past two years the parsonage garden at Kaiapoi has afforded shelter to this industrious mouse-catcher; in another place a small niche in an out-house was tenanted by a More-pork.

Here, beneath the verandahs, we have known it prey on the moths that have been fluttering on the outside of the windows, attracted by the strong light within doors.

We have the egg from the Westland Bush, taken from a hole in a tree —white, smooth, of a rounded rather than oval shape, measuring through the axis 1 inch and nearly 6 lines, with a breadth of 1 inch 3 lines; weight of a More-pork about 5¼ ounces.

It should be stated that castings described by Dr. Buller in his "History" (p. 20), as those of the owl, are castings of the kingfisher (*Halcyon vagans*), which were collected by the writer in Governor Bay, and placed by him in the Museum.

Near the Ohungua River nests have been found with two and three eggs therein.

No. 8.—Neomorpha gouldi, *Gray.*

Huia.

Mr. J. D. Enys has been kind enough to forward some notes taken during a visit to Akitio.

Two specimens, obtained July 3rd, 1873, weighed—Male, 353 grains; female, 306 grains.

Three specimens, killed September 9th :—

		Total length.	Spread of wing, from tip to tip.	Bill.
No. 1 Male	...	18 inches	17·5 inches	2·19 inches
No. 2 „	...	20 „	19·5 „	2·19 „
Female ...	...	19·75 „	20·5 „	3·69 „

No. 18.—ACANTHISITTA CHLORIS, *Sparrm.*

Creeper.

On a station near the Harper River, in this Province, a pair of these small birds made their nest in the skull of a horse. Average weight of these birds is about a quarter of an ounce, the turn of the scale in favour of the female.

No. 19.—ORTHONYX OCHROCEPHALA.

Yellow-head.

Average weight of specimens, 1½ ounce.

No. B. 19.*—CERTHIPARUS ALBICILLA, *Less.*

ORTHONYX ALBICILLUS, *Gml.*

White-head.

The writer procured several specimens of this creeper at Pakuratahi, at the foot of the Rimutaka range, Wellington. Closer observation induces the belief that this species may be separated from *O. ochrocephala*, in order to place it near to *Certhiparus novæ-zealandiæ*.

Irides grey, darkest in the female ; ovary not in a forward state ; circumference of thigh after skinning, three inches ; muscles supporting the back of the head and neck very prominent. In one of the male specimens at least half the under tail-coverts was tipped with white.

Eye-witnesses informed Mr. Enys that the male tears the surface of rotten logs ; the female extracts the insects, which are shared between them. At any rate the male gets his share of his mate's labours.

In life the wattle looks concave. Mr. Enys was reminded of the crow (*Glaucopis*) in some of their movements ; sometimes four to six were found in company.

One of the males killed on September 9th had not moulted ; the tail was dirty and scrubbed, giving it a rusty look, which may account for the so-called Red-tailed Huia.

No. 23.—GERYGONE.

Dr. Buller's idea that the *Gerygone sylvestris* is *G. frontata* is not concurred in by the writer. The new bird bears much more resemblance to *G. flaviventris*.

No. 29.—PETROICA MACROCEPHALA, *Gml.*

Yellow-breasted Tit.

The Yellow-breasted Tit often shows a seeming want of care in choosing

* No. 27 in Vol. II.

its nesting place. A site is selected which perhaps may be admirably adapted for concealing the nest, yet ofttimes the foundation is laid where the structure is liable to be blown out by gusty winds or cast over, so that its contents are destroyed; several instances of such mischances have we seen. The beautifully-made home is probably entirely the work of the hen. We have never seen the cock actually place the materials, yet he does his share of labour in carefully feeding his mate, not only during the resting-time of incubation, but also whilst the nest is being built; he carries the insects he has collected to the close neighbourhood of the busy hen, and calls her to the feast. The hen commences sitting before her full number of eggs is laid, and when she *leaves*—not when she is driven from—her charge, feathers are carefully arranged above the eggs or young. Compared with some species, the young birds are fed for rather a long time in the nest.

A pair this season built in the roof of a bed-room in Christchurch, but did not succeed in rearing any young ones.

The male weighs not quite half an ounce, being slightly heavier than the female.

Note.—January 11th, 1873. Nest on moss-covered stump, Milford Sound.

No. 36.—Keropia crassirostris, *Gml.*

The average weight of Thrushes of either sex may be called 3½ ounces.

No. 37–8.—Rhipidura.

Flycatchers.

August 28th and 29th.—At Ohinitahi, this spring, the writer had two *union* nests under observation almost from the foundation of the structures being fixed. In one case the black parent bird (*R. fuliginosa*) was distinguished with the white spot over each ear; in the second instance the dark bird had not any white spot. As these nests were being built simultaneously, season had nothing to do with the assumption of the white plumelets.

The weight of *R. flabellifera* does not exceed a quarter of an ounce.

No. 40.—Glaucopis cinerea, *Gml.*

Kokako.

Orange-wattled Crow, or Wattle-bird.

The representatives of the *Corvidæ* are to be met with on either side of Cook Strait. The Middle Island species is the Orange-wattled Crow (*G. cinerea*). It is being driven away by the approach of the colonist, for as the coast-line of a large portion of New Zealand exhibited signs, or echoed the sounds of the work of the settler in his encroachments on the tangled wilderness of nature, the Kokako retired to the higher and more remote bushes of

the interior. To give an instance: Banks Peninsula, so often cited by Dr. Finsch, where the Crow once abounded, is now divided into sheep runs or dotted with dairy farms; the once silent woods now resound with the blows of the felling-axe or the harsh grating of the saw-mill. It is not a matter for surprise that the Wattle-bird is no longer to be found in its old haunts; it seeks shelter amongst the higher parts of the bushy gullies—a refuge at once precarious and temporary. It may be thought that the bird has attained a secluded habitat, but the condition of the forest is rapidly changing under the effects of clearings and constantly-recurring bush fires. There is not much doubt that the climate of the district has become modified; at a certain period of the year weeks of drought prevail. The Kokako loving a moist temperature will probably soon entirely forsake its ancient places of resort. These remarks on Banks Peninsula, as an habitat for arboreals, are more or less applicable to a very large extent of country on the eastern side of the Southern Alps.

Under favourable conditions the Kokako may be found on the outskirts of the bush, in the open glades that fringe some of the larger rivers. The gentle, confident manners, the rich, flute-like notes, the peculiar mode of progression even, cannot fail to draw the attention of the observer, albeit he may not be imbued with enthusiasm for gazing on the life that stirs in our woods. The ardent naturalist, who has the chance of knowing this bird, must learn to love it.

In the earlier spring months we have watched it out on the open glade cropping various species of *Graminiæ*, *Gnaphalia*, *Polypodia*; often has its soft note attracted us to the bush where it has been feeding on the leaves of *Melicytus*, *Carpodetus*, etc. As summer advances, ripening the clustering drupes and berries, the fruits of the *Fuchsia* and the *Coriaria* afford an abundant supply of a favourite food. We have found it engaged, seemingly in a search for insects, prying amongst the hoary filaments of the drooping grey-beard moss that decks the branches of so many trees in some of the gloomy alpine valleys. The long tarsi carry the body well above the damp mosses when collecting its food on the ground; its mode of progression, by a series of leaps or bounds, may also tend to keep its plumage clear of humid plants. When really alarmed it leaps with great rapidity, covering a wide space of ground with each effort. Like the *Keropia*, it seeks safety amidst the low undergrowth of the forest.

The sexes appear to be united in close companionship. We have noticed a pair on some favourite fruit-bearing tree caressing each other with their beaks. A pair kept in confinement lived thus imprisoned for about two years, but when one died its mate only survived some few days.

In December, 1869, Donald H. Potts, one of the writer's sons, found a

nest on the outstretched limb of a broad-leaf tree (*Griselinia littoralis*), a few feet above a creek. This was on the Havelock River.

In January last, whilst exploring the bush that fringes Milford Sound, the writer was so fortunate as to discover five nests, at heights varying from ten to seventeen feet above the ground. The first specimen we found placed on the extended limb of a totara (*Podocarpus*) that overhung a deep, ferny gully. The nest had been reared on the remains of an old structure, and the foundation, which was quite two feet across, made of sticks and sprays firmly interlaced, supported a basin-shaped nest formed of twigs and moss (*Sphagnum*), smoothly lined with leaves of soft grass. From wall to wall outside the measurement was found to be 16 inches; diameter of the cavity 8 inches, with a depth of 3·5 inches.

The parent bird on the nest allowing a very close approach, was found to be covering two nestlings as yet unable to see. They were partially clothed with slate-coloured down, which, on the cranium, stood up like a broad crest, or rather crown; the neck and under-parts were quite bare; beaks flesh-colour, with a greenish tinge about the point of the upper mandible; rictal membranes pale greenish, changing to blue; wattles rosy pink, like an infant's hand; legs and feet slatish anteriorly, dull flesh colour behind; claws dull white. They differed somewhat in size; both were very plump, being abundantly fed with the berries of the tutu (*Coriaria*). The old bird suffered a close examination of its home and its inmates without uttering any alarm cry or showing any signs of defending its young, thus differing much from the habit of *Keropia*; yet there was not that exhibition of utter helplessness which some birds—as for instance *Hymenolaimus*—manifest under similar circumstances. The other nests were found in damp situations (one with a broken egg) in a small patch of bush at Freshwater Basin, close by the Lady Bowen Waterfall. From observation we found that the young are left at intervals during the day for a considerable time.

A friend sent two eggs from a nest found near the Paringa River, Westland. They are of a warm stone colour, with purplish and brown spots; ovo-conical; in length 1 inch 7 lines; in breadth 1 inch 1 line. They bear much resemblance to the eggs of some species of *Terns* in colour and marks. We are inclined to believe that eggs of this bird are often destroyed by the long-tailed cuckoo (*Eudynamis tahitiensis*).

The weight of the female Crow is 10¼ ounces, whilst that of the male is found to average from 9½ to 10 ounces.

The writer found that in the Wairarapa the *Glaucopis wilsoni* is sometimes familiarly known as "the blue-gills."

It is said that *G. cinerea* has been found in the North Island.

No. 47–50.—Platycercus.

We have a beautiful specimen of the nest of *P. novæ-zealandiæ*, cup-shaped, built entirely of feathers, moss, and down from the tree-fern (*Dicksonia squarrosa*). A correspondent has communicated the following abnormal conditions of plumage in specimens of this genus :—"*P. novæ-zealandiæ.*—Plumage yellow ; also a specimen with blue plumage, forehead and top of head dirty white, without any mark or spot on each side the rump. *P. auriceps.*—A specimen with yellow plumage."

No. 51.—Nestor meridionalis, *Gml.*
Kaka.

Some eggs of this Parrot in the collection of the writer differ from the usual type, their surfaces being very coarsely granulated. The nest contained five eggs, and was taken from the bush near Invercargill, South Otago.

A form of *Nestor* not yet described has been found near Cass River, in this Province. The dead bird was found in bad condition ; it had the tail feathers beautifully coloured with vermilion, without bars, the shafts much produced into hair-like points ; the wing-feathers with inner webs of delicate vermilion toning down to yellowish.

Kakas, male and female, weigh from 1℔. 2ozs. to 1℔. 5ozs.

No. 57.—Eudynamis tahitiensis, *Gml.*
Long-tailed Cuckoo.

In December, 1872, two instances came under the writer's notice of this bird being reared in gardens in Christchurch ; somewhat later Donald Potts saw one being fed in the Irishman scrub (*Discaria toumatou*), close to the River Potts ; in each of these cases the foster-parents were grey warblers (*Gerygone flaviventris*). The writer differs entirely from Dr. Buller in attributing compassionate philornithic feelings to the foster-parent ; he looks on the *Gerygone* as a dupe simply. In the paper on the crow (*Glaucopis*), page 154, "History of the Birds of New Zealand," we may again find something like a belief on the part of Dr. Buller that a philornithic spirit prompts the yellow-head to feed and tend the offspring of the crow.

Through the "Ibis" the writer tried to obtain some information about the egg of *Eudynamis*, but without success ; he was referred to the two eggs labelled koekoe, from the Buller collection. This bird abounds on the west coast of this island, and the Maoris say "it comes with the mosquitos." Crane-flies form a favourite portion of its food supply. The Long-tailed Cuckoo weighs 4¾ ounces.

No. 58.—Chrysococcyx lucidus, *Gml.*
Whistler.

Having long since taken much interest in bird notes, many observations have

been made on those of the Whistler; yet repeated attempts have failed to discover any guide why the number of its notes should so greatly vary; whether the bird's call is affected by the state of the atmosphere, temperature, the force of the wind, or the quarter whence it blows.

At all hours it may be heard in its season, but at night the call seems most sustained, both as regards the distinct notes or whistles, and the remarkable song or flourish with which it often ends the performance.

SOME NOTES, TAKEN FROM OCTOBER 25TH TO NOVEMBER 10TH.

Lowest and Highest Number of Notes.

11.30 p.m. to 1 a.m.	14 to 34
3.45 a.m.	18 to 41
4.45 a.m.	15 to 24
6.45 a.m.	13 to 25
11.45 a.m. to 0.20 p.m.	3 to 42
4.30 p.m.	11 to 35
6 p.m.	12 to 44
9 p.m.	18 to 68
10.5 p.m.	17 to 64
11 p.m.	25 to 107

The notes do not include the terminal song or flourish.

October 8, 1872.—Whistler heard for the first time.

October 6, 1873.—Just heard the Whistler's call; this is early, as the spring is a late one. Their route on arrival seems to be from W. to E., or N.W. to S.E.

In the early morning the call of the Cuckoo is certainly more plaintive in tone than at other times. This call is delivered without that evident labour which accompanies the outpourings of some species of birds. Whilst performing it sits rather low on its perch, the head is slightly raised, the bill pointing rather upwards, the head is slowly moved from side to side.

November 4.—Female Whistler killed by dashing against the plate-glass windows; irides liver brown, inclining to reddish brown; tarsus and toes slaty blackish, beneath dirty flesh; ovaries not in an advanced state.

November 11.—Another female Whistler suffered a similar fate.

November 12.—Whistlers feeding on the moths that are busy about the ngaio trees (*Myoporum lætum*); in picking off the moths the gape is opened very wide. Whilst feeding a few low, brief notes are uttered.

Have seen this Cuckoo hotly pursued by the black fantail (*R. fuliginosa*). When alarmed its call sounds like "peewau, peewau."

NO. 59.—CARPOPHAGA NOVÆ-ZEALANDIÆ, *Gml.*

Pigeon.

Perhaps few birds show more art in the construction of their homes than does the Pigeon in the arrangement of the slender twigs which form the well-poised platform on which it rears its young. The slight fabric, which at first glance appears of a rude, careless make, has its materials so nicely adjusted as to bear with safety the weight of its heavy builders. It may be said to resemble somewhat the hollow of the human hand. In the slight depression

of the platform the egg, or young, lies undisturbed by the swaying caused by the passing wind.

Last January, in Milford Sound, the writer obtained several nests, in one of which was a young one a few days old.

January 9.—Nest near the Cledau River, in a sapling miro (*Podocarpus*), about 18 feet above the ground ; it contained one young bird sparsely covered with brownish yellow down, which was longest over the neck and breast ; abdomen bare ; bill dull flesh, inclining to slaty ; round the eye bare ; yellowish spot on upper mandible ; legs, feet, and claws leaden to flesh colour. On the nest, with the young bird, there yet remained some fragments of egg-shell and pieces of dung. The spaces and openings of the latticed nest befit the dirty habits of the Pigeon ; as the excrement dries, probably most of it disappears through the nest.

The writer has a beautiful specimen of the nest from Little River Bush, Banks Peninsula ; it was built on a totara (*Podocarpus totara*), on a branch covered with *Loranthus micranthus*, and contained one fresh egg (April 14th). The egg, of pure and glossy whiteness, is of a perfect oval form, measuring in length 1 inch 10 lines, with a breadth of 1 inch 4 lines.

A Pigeon weighs 1lb. 10oz. ; sometimes this is rather exceeded.

In July and August this bird feeds on the *Polypodium australe*.

No. A. 65.—Charadrius obscurus, *Gml.*
Plover.

In October last Donald Potts found a nest which contained four eggs ; three of these were those of the Plover, the fourth being that of the common tern, *S. antarctica.*

No. B. 65.—Anarhynchus frontalis, *Quoy.*
Crook-bill.

In the "Ibis," January, 1873, also in Dr. Buller's book, page 219, appear statements that the pectoral band is less conspicuous on the left than on the right side of the Crook-bill. The fact is, that the shape of the pectoral band is not very regular, and that the black feathers may be found to be most conspicuous either on the left or right side in different individuals, as any one can ascertain who looks through a series of specimens when he may not have the opportunity of noticing living birds.

No. C. 65.—Thinornis novæ-zealandiæ, *Gray.*
Masked Plover.
Tuturautu.

In the summer months this gay-looking Plover affects sandy beaches of the sea-shore. Near to the outfall of a river seems a favourite place of resort ; there *débris* carried down the stream, and cast on the bank by the opposing

tides, affords shelter to numerous insects on which the Masked Plover delights to feed.

To those who are acquainted with our *Charadriæ*, the *Thinornis* must seem to have much in its ways that is common to *C. bicinctus*, as, for instance, there is a marked similarity in the style of flight, in the notes, and calls; the clicking alarm-cry whilst on the wing is common to both birds.

The Masked Plover is said to be rare. In the Catalogue of the New Zealand exhibits in the Vienna Exhibition, 1873, this bird is marked "very rare." It is not unlikely that the idea of its reputed rarity has arisen rather from the lack of close observation than from the scarcity of the species.

Wary, active, and bold, it watches every movement of the intruder on its feeding-ground with attention; it evinces uneasiness by flying in wide circuits at no great height. On alighting it often runs a few yards, covering the ground with rapidity.

Advantage is taken of any high ground for a look-out. When employed in watching the head is frequently moved up and down; when all appears quiet the search for food is resumed amongst the drift-wood, sticks, and sun-dried Algæ, that mark the limits of the highest tide.

Tuturautu, the name given to it by the natives, is expressive of the call-note; perhaps an idea of its sound could scarcely be better rendered. The alarm-cry is like "click, click," repeated rather fast three or four times; after a brief pause the warning is again sounded.

The male has a bright orange coloured bill which sets off its handsome plumage to advantage; the female has its colours distributed in much the same way as her mate, but these are far less conspicuous in tone. Dull, smudgy brown, in unobtrusive tints, lends security to the brooding bird.

Note.—December 31. Watched three pairs near the mouth of the Waikawa River, Otago. A single pair was first seen, but their alarm-note brought the other couples from some distance along shore; these latter, after a brief but wary inspection, departed. From the screen formed by the crest of a sand-dune the birds were watched; they were most probably breeding. At the slightest change of position on the part of the observer both Plovers left off their food search, and made a restless circuit that brought the intruder into full view; both birds showed boldness, the female alighting within three yards' distance of the writer, near enough for the colour of the irides to be distinguished. It is probable that the female has been described under the name of *T. rossi.*

No. 85.—Ortygometra affinis, *Gray.*

Weighs one and a quarter ounces.

No. 86.—Ortygometra tabuensis, *Gml.*

We have the egg of this widely-distributed Rail from a salt-marsh near

Invercargill. It is rather a long oval in shape; measures one inch nearly four lines through the axis, the breadth being about ten lines; colour olivaceous brown.

No. A. 89.—Ocydromus fuscus, *Du Bus.*

Kelp-hen, Blackwood-hen.

It abounds in the many inlets and sounds of the south-west coast of this island. The only place where we noticed that it seemed shy was in Milford Sound. As soon as the tide begins to recede these dusky Rails come out on the shore to feed amongst the kelp. In January last we procured, without difficulty, a number of specimens of either sex, both in the young and adult state.

In the living state we observed that the bill was pink at the base, pale brown towards the tip; irides chestnut red; legs and feet red; claws brown.

The young have the legs as red as the adult bird; irides dull yellowish; bill dark colour.

No. B. 89.—Gallinago pusilla.

A specimen of the Snipe has been recently obtained on The Snares.

No. 102.—Eudyptes.

Mr. Morton has informed the writer of the occurrence of a Black Penguin corresponding in size with *Eudyptes pachyrynchus*. It was captured on The Snares.

No. A. 108.—Ossifraga alba.

White Nelly.

Off Centre Island, Foveaux Straits, a fine specimen of the White Nelly was captured by Mr. Enys, on January 3rd. It was feeding on the refuse from the vessel in company with several specimens of the Common Nelly.

Plumage white, mottled very sparingly throughout with single brownish grey feathers; bill pale greenish; sutures flesh colour, yellow at the tip; legs and feet slate grey. Entire length 34 inches. Spread of wings across the body 77·5 inches; wing, from flexure, 20 inches 6 lines; tarsus 3 inches 6 lines; middle toe and claw 5 inches 4 lines; outer toe 5 inches; spread of web 7 inches; bill 3 inches; lower mandible 3 inches; beak 1 inch; gape to centre of eye 1 inch; height of beak 1 inch.

The day before the wind had been blowing hard from the south. On the 15th January, in Cook Strait, we observed another specimen, it had been blowing a furious gale on the day before.

No. 123.—Diomedea melanophrys, *Boie.*

Molly-mawk.

An egg of this sea-fowl, from the Auckland Isles, is white, with a few small rusty marks; ovoi-conical in form. It measures four inches four lines in length, with a breadth of two inches ten lines.

No. 124.—LESTRIS CATARRACTES, *Q.* and *G.*

An egg of this species, brought by Mr. H. Travers from the Chatham Isles, is ovoi-conical in form ; the colour is olivaceous brown, blotched and dotted with dark brown ; it measures nearly 3 inches in length, with a breadth of 2 inches 1 line.

No. 126.—LARUS DOMINICANUS, *Licht.*
Large Gull.

In certain localities the habits of our Large Gull seem so peculiar as to deserve some notice. About the sounds it is apparently far less gregarious than it is usually found to be on our eastern shores. Has the custom of flocking together been abandoned, or is it yet unacquired ? Fish is as abundant on the western side as it is here, so that any difficulty in the food supply does not seem to be the cause of different habits. It breeds solitarily on little islets, stumps, or roots of stranded trees. The nests are large, substantial structures, showing a degree of labour and care in their construction which is not matched by the birds on our side of the island. Some found by the writer, in Milford Sound, were large nests formed of a vast variety of materials, and so solidly built that they were brought away without the least damage. The young keep to the nest for some time, lying on the broad walls basking in the sun ; from the castings we found they were fed on young mussels, etc. These Gulls prey on the young of other birds, such as those of the teal for instance, which are swallowed at a gulp.

No. B. 131.—STERNA ALBA, *Potts.*

The White Tern seen by the writer on the Ashburton, and described by him in Trans. N.Z. Inst., Vol. III., is quietly placed by Dr. Buller with *S. nereis*, to which he gives the name of the Little White Tern.

This fine White Tern was seen on the Waitangi River by the Hon. G. Buckley, and others. Last month (November 20) a pair were seen flying up and down the course of that great river.

It is satisfactory to be able to record a second notice of the occurrence of this bird in the breeding season.

ART. XXXI.—*Note on the Occurrence of* Dermestes lardarius *and* Phoracantha recurva *in Canterbury, New Zealand.* By C. M. WAKEFIELD.

[*Read before the Philosophical Institute of Canterbury, 2nd April,* 1873.]

ON the 12th of last February I captured a specimen of *Dermestes* in a box of insects lately received from Australia by Dr. Haast for the Christchurch Museum. Upon comparing it with a specimen of *D. lardarius* taken at

Rome, I am unable to detect any difference. I feel certain, therefore, that this cosmopolite devourer has found its way to New Zealand. I find that a species of *Dermestes*, from this country—*D.carnivorus* (*versicolor*, Castelnau)—was long ago described by Fabricius, but I have never seen it, or even its description. The genus *Dermestes* was first established by Linnæus (Syst. Nat. Ed., 12, II., p. 561), and its characteristics may be found in Lacordaire, Vol. II., p. 461. From the same author I gather that the insects of this genus, in all their stages, live principally upon animal substances, apparently giving preference to those which are partly desiccated, but that in other respects their taste is so little exclusive that they may be considered almost omnivorous. Placed in favourable circumstances they multiply with great rapidity, and become exceedingly troublesome. Most of them have a very extended geographical distribution, so much so that it is often difficult to determine their true country. The other insect which I have to notice is a much larger and more conspicuous one.

In the early part of the same month a daughter of Mr. Tully, of Middleton, near Christchurch, found a very remarkable Beetle upon the wall of his cow-shed. The insect was forwarded to Mr. Fereday, and by him kindly given to me. From the brilliancy of its markings, so different to the dull and sombre hues which generally characterize the fauna of New Zealand, we at once concluded that our specimen was a visitor from Australia, and upon comparing it with some Victorian types in the Christchurch Museum, we found its name to be *Phoracantha recurva.* The genus *Phoracantha* belongs to the remarkable family of Coleoptera, Longicornia, and contains many large and handsome species much superior to the one under consideration. All its members are wood-borers, so it is easy to account for the introduction of any of them into the Province. Probably our specimen arrived in some of the timber imported for the railway, near which it was found. Considering the constant traffic between Australia and New Zealand, the appearance in the latter country of *Dermestes* and *Phoracantha* is in no way remarkable, being, in fact, just what might have been expected; but it is most important that the first appearance of all new species should be accurately noted and placed on record.

The genus *Phoracantha*, with the exception of one species which occurs in New Caledonia, is peculiar to Australia. Its name was first established in 1840, by Newman (Ann. of Nat. Hist., V., p. 19), and its characteristics may also be found in Lacordaire, "Genera des Coléoptères," Vol. VIII., p. 303. Dieffenbach (Vol. II., p. 278) mentions a *Phoracantha dorsalis* as occurring in New Zealand, but I know nothing more of it.

ART. XXXII.—*Notes upon certain recently-described New Genera and Species of* Coleoptera, *from Canterbury, New Zealand.*

By C. M. WAKEFIELD.

[*Read before the Philosophical Institute of Canterbury, 4th June,* 1873.]

BY the last mail I received from Mr. H. W. Bates, the well-known South American traveller and vice-president of the Entomological Society of London, a letter containing some valuable information respecting a few Coleoptera which I forwarded to him from this Province in October last. I give the greater part of it *verbatim*, and exhibit specimens of the new species referred to, which I shall afterwards place in the Museum. Mr. Bates writes as follows :—

"I distributed the Coleoptera which you kindly sent me in the little box, amongst a number of entomologists especially devoted to the various groups, telling them to keep the specimens in exchange for the names. After much delay I have got replies from all of them, but there still remain a few species of which no one knows anything. The result is on the adjoining page. They are all (myself included) willing to describe the new species, but all say it is very requisite to have several specimens and both sexes to do this satisfactorily. You will get finer things and more species from the hilly districts. You will observe the large amount of new species, and even of new genera; this shows what a fine new field you have. I saw Mr. Scott, and he told me he was willing to undertake your Hemiptera. Mr. Verrall, secretary to the Entomological Society, is willing to describe your Diptera."

"LIST OF COLEOPTERA.

No.

2. *Demetrida picea* (Chaudoir). There are several pretty spotted species of this genus in New-Zealand, very rare in collections here.
3. *Dicrochile*, n. sp. There appear to be several closely allied species of this pretty genus, which is distinguished by its bilobed labrum (upper lip).
4. *Pterostichus.* More specimens wanted.
5. New genus near *Cymbeba* (Pascoe). Family Heteromera.
7. *Xantholinus punctulatus.* English species imported.
8. *Aphodius granarius.* " "
9. *Cercyon flavipes.* " "
13. *Selenopalpus strigipennis* (White).
14. *Lemidia obscura* (Pascoe), n. sp.
15. *Ptinus fur.* English, imported.
16. *Titæna rugiceps* (F. Bates). Heteromera.

17. Two species under this number—*Stephanorhynchus colaspis*, n. sp.; and n. sp. (*Curculio*).
18. *Dryocora howittii* (Pascoe).
22. *Pericoptus*, n. sp. More wanted.
24. *Inophlœus villaris* (Pascoe), n. sp.
26. *Irenimus parilis*, nov. gen.
27. *Navomorpha*, n. sp. More wanted.
28. *Anemma fulvipes* (Pascoe), n. g., n. sp.
30. *Cilibe punctata* (F. Bates). Heteromera.
31. *Cyttalia*, n. sp.
32. *Ceresium*, n. sp. More wanted.
33. *Cilibe thoracica* (F. Bates). Heteromera.
34. *Odontria*, n. sp. More wanted."

The above is only a preliminary note, and the descriptions, with (I hope) figures, have yet to arrive; still, I think, the information contained in it considerably advances our knowledge of the entomology of New Zealand. We are now able to ascertain with very tolerable accuracy the names of fifteen species of Coleoptera previously unknown to anyone in the colony; and have learnt to which genera at least five more species belong. It is interesting to note that four species, viz., *Xantholinus punctulatus*, *Aphodius granarius*, *Cercyon flavipes*, and *Ptinus fur*, are identical with those of England, and have, doubtless, been imported from thence. *Aphodius* and *Cercyon* confine themselves exclusively to the dung of animals, and could hardly, therefore, have existed in New Zealand previous to its colonization. I first observed *Aphodius* in this Province about seven years ago. It was then very scarce, and I could only procure a couple of specimens for my collection. Last spring it was quite as numerous upon our roads as any of the allied species are in Europe. I never saw *Cercyon* before last year, but it is now as abundant as the other.

In a former paper I noticed the occurrence of *Onthophagus granulatus* in Nelson, and, as time passes, it will be curious to observe whether any of the larger coprophagous Beetles, such as *Ateuchus*, *Copris*, or *Geotrupes*, find their way to these islands. I may remark that all Beetles of this family are desirable colonists. The same cannot be said of *Ptinus fur*, which is a well-known pest in the Museums of Europe, and even here we have had some experience of its destructive propensities.

The largest and most remarkable of the new species is the *Pericoptus*, and I look upon the thorough investigation of its habits as one of the most interesting problems in our natural history; but I am still very much in the dark respecting it.

The new genus allied to *Cymbeba* is noteworthy as showing how very little has hitherto been done towards the classification of our insects, for this is one

of the commonest Beetles in the neighbourhood of Christchurch, and yet it proves to be not only a new species but a new genus. The same remark will apply almost equally well to *Irenimus* and *Cyttalia*, the latter of which is very common in spring upon the "Spaniard."

The *Ceresium*, too, is anything but rare on the Peninsula, and, altogether, I have been astonished to find how many new genera and species are contained in this very small collection of Beetles.

It will be seen that the thirty-four species referred to were divided amongst three or four of the best entomologists in London, and that eleven of them remain undetermined. From this we may form some idea of the difficulty of the task, which I consider to be one that could not be properly performed in the colony. The temptation to describe our own species is, of course, obvious, since, by the etiquette of science, and indeed by the necessity of the case, it is the describer, and not the discoverer, who obtains the credit of introducing a new species; but in the present state of knowledge no one man could well undertake more than a single group of insects. Until, therefore, science shall have been much more widely cultivated in New Zealand, reference to Europe will be absolutely indispensable, and, in spite of the delays, disappointments, and expense attendant upon such a course, I am encouraged to persevere in it by the result of Mr. Bates' letter. But, in order that we may reap the full benefit of the labours of English naturalists, it is necessary that all descriptions of New Zealand animals published in the scientific periodicals of Europe should be at once reprinted in our "Transactions." I am convinced that the funds at the disposal of the Institute could not be applied to any better purpose, and I think that the general rule—prohibiting the printing of any but original matter—might be advantageously dispensed with in this instance. At present I have a most elaborate and painstaking pamphlet on the New Zealand Trichoptera, by Mr. M'Lachlan, but, so far as the scientific public of these islands are concerned, it might almost as well be non-existent, for I do not believe that more than a couple of copies exist in the colony. I must, however, take this opportunity of expressing a hope that no one will forward insects to England without stipulating that a specimen of each new species, with name and description attached, be returned to us here. Much mischief and confusion has, undoubtedly, arisen from the indiscriminate despatch of specimens of natural history to Europe.

In conclusion, I may mention that I have lately forwarded a considerable number of Coleoptera, Neuroptera, and Hemiptera, to Messrs. Bates, Scott, and M'Lachlan, and, with their kind assistance, I hope shortly to be able to introduce something like order into the chaos of New Zealand entomology.

Art. XXXIII.—*List of the Insects recorded as having been found in New Zealand previous to the Year* 1870. By Capt. F. W. Hutton, C.M.Z.S.

[*Read before the Otago Institute, 11th November,* 1873.]

It is with considerable diffidence that I present the following list to the Otago Institute, for I am well aware that it must contain many errors, both of commission and omission; but as it has had the advantage of being revised and considerably added to by C. M. Wakefield, Esq., it is, I think, as complete and accurate as it can be made in the colony, and it will, I hope, be found useful as a first step towards collecting together descriptions of all the New Zealand Insects.

It contains the following number of species of each order:—Coleoptera, 265; Hymenoptera, 23; Diptera, 98; Neuroptera, 42; Orthoptera, 30; Heteroptera, 22; and Homoptera, 22; making a total of 502 species, but of these 15 are names merely, no description or figure having been published.

A list of the Lepidoptera will, I hope, shortly be published by Mr. R. W. Fereday.*

COLEOPTERA.

Cicindelidæ.

Cicindela tuberculata, Fabr., Syst. Eleuth, I., 238, 32.
,, *douei*, Guerin, Mag. de Zool., 1840, t. 45.
,, *latecincta*, White, Voyage Erebus and Terror, Insects, 1.
,, *parryi*, White, l.c., 1.
,, *dunedinensis*, Castelnau, Trans. Roy. Soc. Victoria, 1867, VIII., 35.
,, *feredayi*, Bates, Ent. M. Mag., 1867, IV., 53.
Distipsidera fasciata, Motschulsky, Bull. Soc. Nat. de Moscou, XXXVII., 174.

Carabidæ.

Cymindis dieffenbachii, White, l.c., 2; *C. australis*, Blanchard.
Sarothrocrepis binotata, Blanchard, Voy. au Pole Sud, 12.
Demetrida lineella, White, l.c., 2.
,, *picea*, Chaudoir.
,, *nasuta*, White, l.c., 2.
Dromius fossulatus, Blanchard, l.c., t. 3, f. 16.
Actenonyx bembidioides, White, l.c., 2.
Colpodes submetallicus, White, l.c., 2.
Coptodera antipodum, Bates, l.c., 78.
Metaglymma monilifer, Bates, l.c., 78.
,, *aberrans*, Putzeys, Stett. Ent. Zeit., 1868, 320.
Sphallax peryphoides, Bates, l.c., 56.
Bembidium maorinum, Bates, l.c., 79.
,, *charile*, Bates, l.c., 79.
Anchomenus elevatus, White, l.c., 3.
,, *colensonis*, White, l.c., 3.

* See Art. XXXIV.

Anchomenus deplanatus, White, l.c., 3.
„ *atratus*, Blanchard, l.c., t. 1, f. 15.
„ *novæ-zealandiæ*, Fairmaire, Ann. Soc. Ent., 1843, 12.
„ *marginellus*, Erichson, Archiv., 1842, I., 130.
Feronia planiuscula, White, l.c., 3.
„ *vigil*, White, l.c., 3.
„ *australasiæ*, Blanchard, l.c., t. 2, f. 13.
„ *subœnea*, Guerin, Rev. Zool. Cuv., 1841, 122.
„ *capito*, White, l.c., 4.
„ *politissima*, White, l.c., 4.
„ *vagepuncta*, White, l.c., 4.
„ *elongella*, White, l.c., 4.
„ *rectangula*, Chaudoir, Bull. Soc. Nat. Moscou, XXXVIII., 74.
„ *impressifrons*, Chaudoir, l.c., 93.
„ *reflexa*, Chaudoir, l.c., 94.
„ *angustula*, Chaudoir, l.c., 101.
„ *ovatella*, Chaudoir, l.c., 105.
Cerabilia maori, Castelnau, l.c., 202.
Promecoderus lottini, Brullé, Hist. Nat. Insectes, IV., 450.
Pedalopia novæ-zealandiæ, Castelnau, l.c., 154.
Rembus zeelandicus, Redtenbacher, Reise Novara Zool., 10.
Mecodema sculpturatum, Blanchard, l.c., t. 2, f. 14.
„ *æreus*, White, l.c., 5.
„ *alternans*, Castelnau, l.c., p. 75.
„ *howittii*, Castelnau, l.c., 159.
„ *rectolineatum*, Castelnau, l.c., 160.
„ *lucidum*, Castelnau, l.c., 160.
„ *crenicolle*, Castelnau, l.c., 160.
„ *simplex*, Castelnau, l.c., 160.
„ *impressum*, Castelnau, l.c., 161.
„ *inæquale*, Castelnau, l.c., 162.
„ *elongatum*, Castelnau, l.c., 162.
„ *crenaticollis*, Redtenbacher, l.c., 11.
Dicrochile ovicollis, Motschulsky, l.c., 316.
Olisthopus (?) *insularis*, Motschulsky, l.c., 325.
Clivina rugithorax, Putzeys, l.c., 1866, 37.
Algolus monarchicus, Motschulsky, l.c., 245.
Megadromus viridilimbatus, Motschulsky, l.c., 251.
Calathrus zeelandicus, Redtenbacher, l.c., 17.
Periblepusa elaphroides, Redtenbacher, l.c., 21.
Omaseus sylvaticus, Blanchard, l.c., t. 2, f. 5.
Argutor erythropus, Blanchard, l.c., t. 2, f. 7.
„ *piceus*, Blanchard, l.c., t. 2, f. 8.
Broscus carenoides, White, l.c., 4.
Helæotrechus elaphroides, White, l.c., 5.
Oopterus rotundicollis, White, l.c., 6.
Molopsida polita, White, l.c., 6.
Maoria tibialis, Castelnau, l.c., 163.
„ *punctata*, Castelnau, l.c., 164.
„ *morio*, Castelnau, l.c., 164.
„ *clivinoides*, Castelnau, l.c., 164.
„ *dyschirioides*, Castelnau, l.c., 164.
Brullea antarctica, Castelnau, l.c., 166.

Harpalus antarcticus, Castelnau, l.c., 193.
,, *novæ-zealandiæ*, Castelnau, l.c., 194.
Drimostoma antarctica, Castelnau, l.c., 199.
,, *striatopunctata*, Castelnau, l.c., 199.

DYTISCIDÆ.

Onychohydrus hookeri, White, l.c., 6.
Colymbetes notatus, Fabr., Ent. Syst., I., 195, 38.
,, *rufimanus*, White, l.c., 6.
Eunectes australis, Erichson, l.c., 134.
Gyrinus striolatus, Guerin, Voy. Coquille, 62.

STAPHYLINIDÆ.

Staphylinus oculatus, Fabr., l.c., II., 251, 10.
,, *quadri-impressus*, White, l.c., 6.
,, *puncticeps*, White, l.c., 6.
Lithocharis zealandica, Redtenbacher, l.c., 29.

SCAPHIDIIDÆ.

Scaphisoma scutellare, Redtenbacher, l.c., 32.

HISTERIDÆ.

Saprinus pseudo-cyaneus, White, l.c., 8.
Hister cinnamoneus, White, l.c., 8.

NITIDULIDÆ.

Nitidula antarctica, White, l.c., 8.
,, *lateralis*, White, l.c., 8.
,, *abbreviata*, Fabr., l.c., I., 348, 5.

ENGIDÆ.

Engis politus, White, l.c., 18.
Bitoma insularis, White, l.c., 18.

MYCETOPHAGIDÆ.

Latridius antipodum, White, l.c., 18.

TROGOSITIDÆ.

Trogosita affinis, White, l.c., 17.
,, *mauritanica*, L. (Tenebrio).
Leperina nigrosparsa, White, l.c., p. 17 (Gymnocheila).
,, *sobrina*, White, l.c., 17.
Apate minutus, Fabr., l.c., 54, 4.

COLYDIIDÆ.

Enarsus bakewelli, Pascoe, Jour. of Ent., 1866, 445.

CUCUJIDÆ.

Dendrophagus brevicornis, White, l.c., 18.
,, *suturalis*, White, l.c., 18.
,, *umbrinus*, Smith, Cat. Coleo. Brit. Mus., 12.
Dryocora howitti, Pascoe, Proc. Ent. Soc. London, 1868, p.
Parabrontes sylvanoides, Redtenbacher, l.c., 40.

CRYPTOPHAGIDÆ.

Cryptophagus australis, Redtenbacher, l.c., 42.

DERMESTIDÆ.

Dermestes carnivorus, Fabr., l.c., 55, 2.
„ *navalis*, Fabr., l.c., 56, 9.
„ *limbatus*, Fabr., l.c., 318, 36.

BYRRHIDÆ.

Curimus zeelandicus, Redtenbacher, l.c., 45.

LUCANIDÆ.

Dendroblax earlii, White, l.c., 9.
Dorcus punctulatus, White, l.c., 9.
„ *squamidorsis*, White, l.c., 9.
Lissotes reticulatus,* Westwood, Proc. Ent. Soc., 1844.
Cerathognathus irroratus, Parry, Trans. Ent. Soc., IV., 56.
„ *helotoides*, Thomson.
„ *alboguttatus*, Bates, Ent. Mag., No. 39, p. 55.
Oxyomus exsculpatus, White, l.c., 9.

SCARABÆIDÆ.

Rhisotrogus zealandicus, White, l.c., 10.
Odontria xanthosticta, White, l.c., 10.
„ *cinnamonea*, White, l.c., 10.
„ *striata*, White, l.c., 10.
Pericoptus truncatus, Fabr., l.c., I., 7, 18.
Eusoma rossii, White, l.c., 10.
Pyronota festiva, Boisduval, Faune de l'Oc., II., 214.
Stethaspis suturalis, Hope, Col. Man., I., 104; *M. chlorophyllus*, Bois.
Cheiroplatys punctatus, White, l.c., 9.
„ *truncatus*, Hope, Col. Man., I., 85.

BUPRESTRIDÆ.

Buprestris eremita, White, l.c., 6.

ELATERIDÆ.

Elater acutipennis, White, l.c., 7.
„ *zeelandicus*, White, l.c., 7.
„ *approximans*, White, l.c., 7.
„ *lineicollis*, White, l.c., 7.
„ *cinctiger*, White, l.c., 7.
„ *lateristrigatis*, White, l.c., 7.
„ *nigellus*, White, l.c., 7.
„ *olivascens*, White, l.c., 7.
„ *strangulatus*, White, l.c., 7.
„ *megops*, White, l.c., 7.
„ *lævithorax*, White, l.c., 7.
Ochosternus zeelandicus, Candèze, Mon. Elat., IV., 446; *E. punctithorax*, White.
Acroniopus grandis, Redtenbacher, l.c., 96.

* *Lucanus antilope* has been erroneously reported as occurring in New Zealand.

Cebrionidæ.

Atopida castanea, White, l.c., 8.

Cleridæ.

Opilus violaceus, Klug., Abh. Berl., 1840, 391.
Aulicus pantomelas, Boisduval, Voy. Astrolabe, t. 6, f. 14.
Notoxus porcatus, Fabr., Hope Col. Man., III., 137.

Ptinidæ.

Anobrium tricostellum, White, l.c., 8.
Ptinus suturalis, White, l.c., 8.
„ *murinus*, White, l.c., 8.
„ *pilosus*, White, l.c., 8.

Bostrichidæ.

Platypus douei, Chapuis, Mon. Platypides, 1865, 237.
„ *apicalis*, White, l.c., 18.
Lyctus brunneus, Stephens, Brit. Ent., III., 117.
„ *depressiusculus*, White, l.c., 18.

Melasomata.

Chærodes trachyscelides, White, l.c., 12.
Bolitophagus antarcticus, White, l.c., 12.
Pristoderus scaber, Hope, Col. Man., II., 181 and 81.
Adelium harpaloides, White, l.c., 11.
Rygmodus modestus, White, l.c., 11.
„ *pedinoides*, White, l.c., 12.
Uloma nitens, Redtenbacher, l.c., 125.
„ *lævicostata*, Blanchard, l.c., 155.
Titæna erichsonii, White, l.c., 12.
„ *interrupta*, Redtenbacher, l.c., 128.
Tanychilus metallicus, White, l.c., 12.
Amarosoma simulans, Redtenbacher, l.c., 132.
Prioscelida tenebrionoides, White, l.c., 11.
Cilibe phosphugoides, White, l.c., 11.
„ *granulosus*, Brême, Man. Cossyph., 39.
„ *elongatus*, Brême, l.c., 38.
Zolodinus zeelandicus, Blanchard, l.c., 160.
Opatrum tuberculicostatum, White, l.c., 11.
„ *lævigatum*, Fabr., l.c., I., 89, 5.

Cistelidæ.

Atractus virescens, Boisduval, l.c., 284.

Melandryidæ.

Nacerdes lineatus, Fabr., l.c., II., 75, 4 (*Dryops*).
Ctenoplectron fasciatum, Redtenbacher, l.c., 137.
Chalcodrya variegata, Redtenbacher, l.c., 138.

Mordellidæ.

Mordella antarctica, White, l.c., 12.

Œdemeridæ.

Selenopalpus strigipennis, White, l.c., 12 (*Dryops*).

Selenopalpus chalybeus, White, l.c., 13.
„ *subviridis*, White, l.c., 13.

CURCULIONIDÆ.

Brachyolus punctatus, White, l.c., 13.
Platyomida binodes, White, l.c., 14.
Otiorhynchus griseus, White, l.c., 14.
Rhadinosomus acuminatus, Schonch., Curc., VI., 473.
Hoplocneme cinnamonea, White, l.c., 14.
„ *hookeri*, White, l.c., 14.
Oropterus coniger, White, l.c., 14.
Scolopterus tetracanthus, White, l.c., 15.
„ *penicillatus*, White, l.c., 15.
„ *bidens*, Fabr., Syst. Ent., 136, 51.
Ancistropterus quadrispinosus, White, l.c., 15.
„ *hochstetteri*, Redtenbacher, l.c., 147.
Psepholax barbifrons, White, l.c., 15.
„ *sulcatus*, White, Dieff. New Zealand, II., 275.
„ *coronatus*, White, Voy. Ereb. and Terr., Insects, 15.
Oreda notata, White, l.c., 16.
Aldonus hylobioides, White, l.c., 16.
Euthryrhinus squamiger, White, l.c., 16.
Pentarthrum cylindricum, Wollaston, Trans. Ent. Soc., 2nd Series, V., 398.
Rhynchodes ursus, White, l.c., 16.
„ *saundersii*, White, l.c., 17.
Stephanorhynchus curvipes, White, l.c., 17.
Curculio modestus, Fabr., Ent. Syst., II., 453, 250.
Euramphus fasciculatus, Shuckard, Ent. Mag., V., 506, t. 18.
Dryophthorus bituberculatus, Schonh., Curc., IV., 1090.
Mecistostylus douei, Lacordaire (1866).
Mitrasthelus baridioides, Redtenbacher, l.c., I., 68.
Paranomocerus spiculus, Redtenbacher, l.c., 169.
Rhinaria sextuberculata, White, l.c., 13.
„ *tridens*, Fabr., Syst. El., II., 537, 186 (*Curculio*).

ANTHRIBIDÆ.

Anthribus incertus, White, l.c., 13.
„ *phymatodes*, Redtenbacher, l.c., 174.

BRENTHIDÆ.

Brentus cylindricornis, Fabr., Ent. Syst., II., 494, 9.
Lasciorhynchus barbicornis, Fabr., l.c., II., 491, 1 (male); *B. assimilis*, Fabr. (female).

SCOLYTIDÆ.

Hylastes peregrinus, Chapuis, Synopsis des Scolytides, 1869, 21.

LONGICORNIA.

Prionoplus reticularis, White, Dieff. New Zealand, II., 276.
Phlyctænodes strigipennes, Westwood, Arch. Ent. II., 27 (*Cerambyx*).
„ *trituberculatus*, Redtenbacher, l.c., 188.
Syllitus suturalis, Olivier (*Cerambyx abbreviatus*, Fabr., Syst. El., II., 275).
Ophryops pallidus, White, Voy. Erebus and Terror, Insects, 19.

Eburida sublineata, White, l.c., 19.
,, *sericea*, Smith, Cat. Coleop. Brit. Mus., 299.
Callipriason sinclairi, White, Dieff. New Zealand, II., 277.
,, *marginatum*, White, Voy. Erebus and Terror, Insects, 23.
Phoracantha dorsalis, Newman, Ann. Nat. Hist., V., 19.
Brachytria pallida, White ; *B. latebrosa*, Newman, Entomol., 95.
Tmesisternus variegatus, Fabr., Ent. Syst., II., 325, 32 (*C. vitticolle*, Newman).
Navomorpha sulcata, Fabr., Ent. Syst., II., 326, 34 (*Callidium*).
,, *lineata*, Fabr., Ent. Syst., II., 325, 33 (*Callidium*).
,, *acutipennis*, White, l.c., 20 (*Coptomma*).
Ceropogon (?) *diversicome*, White, l.c., 20.
Obrium fabricianum, Westwood, Arch. Ent., II., 28 (*Callidium minutum*, Fabr.).
,, *guttigerum*, Westwood, l.c., II., 28.
Œmona villosa, Fabr., Ent. Syst. El., 320, 13 (*Saperda*).
,, *humilis*, Newman, Ent., 8.
,, *tristis*, Fabr., l.c., 186, 11 (*Saperda*).
,, *zealandica*, Blanchard, Voy. Pole Sud, IV., 272.
Tetrorea cilipes, White, l.c., 21.
Diastamerus tomentosus, Redtenbacher, l.c., 177.
Tympanopalpus dorsalis, Redtenbacher, l.c., 180.
Blosyropus spinosus, Redtenbacher, l.c., 188.
Phlyctænodes retiferus, Lacordaire, Gen. des Coléoptères.
Pogonocherus crista, Fabr., l.c., II., 268, 6 (*Lamia*).
Lamia flavipes, White, l.c., 21.
Hexatricha heteromorpha, Boisduval, l.c., 21 (*Xylotoles*).
,, *pulverulenta*, Westwood, Arc. Ent., II., 86 (*Lamia*).
Psilomorpha tenuipes, Saunders, Trans. Ent. Soc. London, 1850, 80.
Agapanthida pulchella, White, l.c., 22.
Dorcadida bilocularis, White, l.c., 22.
Xylotoles griseus, Westwood, l.c., II., 27.
,, *subpinguis*, White, l.c., 22.
,, *gracilis*, White, l.c., 22.
,, *parvulus*, White, l.c., 22.
,, *bimaculatus*, White, l.c., 22.
,, *lynceus*, Fabr., l.c., II., 313, 27.
,, *lætus*, White, l.c., 22.
Parmena antarctica, White, l.c., 22.

PHYTOPHAGA.

Colaspis brunnea, Fabr., l.c., II., 323, 75.
,, *pallidipennis*, White, l.c., 23.

COCCINELLIDÆ.

Coccinella tasmanii, White, l.c., 23.

HYMENOPTERA.

ANTHOPHILA.

Leioproctus imitatus, Smith, Cat. Hymen. Brit. Mus., 9.
Lamprocolletes obscurus, Smith, l.c., 11.
Dasycolletes metallicus, Smith, l.c., 15.
,, *purpureus*, Smith, l.c., 15.

Halictus sordidus, Smith, l.c., 56.
Prosopis vicina, Sichel, Reise Novara, Zool., II., 143.

POMPILIDÆ.

Pompilus fugax, Fabr.; Smith, l.c., 163.
„ *monarchus*, White; Smith, l.c., 164.

CRABRONIDÆ.

Tachytes nigerrimus, White; Smith, l.c., 307.
„ *depressus*, Saussure, Reise Novara, Zool., II., 70.
Pison morosus, White; Smith, l.c., 317.
„ *tuberculatus*, Smith, Trans. Ent. Soc., 1869, 297.
Gorytes carbonarius, Smith, l.c., 366.
Sphex fugax, Fabr., Syst. Ent., 350, 27.

MUTILLIDÆ.

Rhaphigaster novaræ, Saussure, l.c., 112.

FORMICIDÆ.

Ponera castanea, Mayr., Reise Novara, Zool., II., 69.
Orectognathus atennatus, Smith, l.c., 161.
Atta antarctica, White; Smith, l.c., 167.
Monomorium fulvum, Mayr., l.c., 93.

ICHNEUMONIDÆ.

Ichneumon lotatorius, Fabr., l.c., 330, 16.
„ *solicitorius*, Fabr., l.c., 332, 30.
„ *decoratorius*, Fabr., l.c., 333, 32.
„ (?) *luteus*, Fabr., l.c., 341, 75.

DIPTERA.

MYCETOPHILIDÆ.

Rhyphus phaleratus, White, Voy. Erebus and Terror (not described).
„ *neozealandicus*, Schiner, Reise Novara, Zool., II., 49.

BIBIONIDÆ.

Bibio nigrostigma, Walker, Cat. Dip. Brit. Mus., 121.
„ *ruficoxis*, Macquart, Dipt. Exot., Sup., IV., 17, 11.

SIMULIDÆ.

Simulia cæcutiens, White, l.c. (not described).
„ *australensis*, Schiner, l.c., 15.

CULICIDÆ.

Culex argyropus, Walker, l.c., 2.
„ *iracundus*, Walker, l.c., 6.
„ *acer*, Walker, l.c., 8.

TIPULIDÆ.

Limnobia gracilis, Haliday, Voy. Erebus and Terror (not described).
„ *chorica*, Haliday, l.c. (not described).
„ *ægrotans*, Haliday, l.c. (not described).
„ *tessellata*, Haliday, l.c. (not described).

„ *repanda*, Haliday, l.c. (not described).
„ *fumipennis*, White, l.c. (not described).
„ *conveniens*, Walker, l.c., 57.
„ *vicarians*, Schiner, l.c., 46.
Tipula senex, White, l.c. (not described).
„ *dux*, White, l.c. (not described).
„ *clara*, White, l.c. (not described).
„ *obscuripinnis*, White, l.c. (not described).
„ *novaræ*, Schiner, l.c., 37.
Cloniophora subfasciata, Walker, l.c., 74.

STRATIOMYDÆ.

Stratiomys dorsalis, Walker, l.c., 536.
„ *angusta*, Walker, l.c., Sup., 57.
Odontomyia chloris, Walker, l.c., Sup., 57.
„ *australensis*, Schiner, l.c., 59.
Clitellaria aberrans, Schiner, l.c., 54.

XYLOPHAGIDÆ.

Diphysa apicalis, Walker, l.c., 1151.
„ *spiniger*, Weid; *Beris servillei*, Macq., Dipt. Ent., I., 1, 172.
Beris substituta, Walker, l.c., Sup., 12.
Actina opposita, Walker, l.c., Sup., 13.

TABANIDÆ.

Pangonia lerda, White, l.c. (not described).
„ *adrel*, White, l.c. (not described).
Tabanus sarpa, Walker, l.c., Sup., 255.
„ *truncatus*, Walker, l.c., Sup., 255.
„ *oplus*, White, l.c. (not described).
„ *impar*, Walker, Zool., VIII., Ap., LXXI.
„ *sordidus*, Walker, Cat. Dipt. Brit. Mus., Sup., 256.
„ *transversus*, Walker, l.c., Sup., 256.
Palecorhynchus ornatus, Schiner, l.c., 98.

THEREVIDÆ.

Thereva bilineata, Fabr., Ent. Syst., 757, 3.
Anabarhynchus luridus, Schiner, l.c., 148.

MIDASIDÆ.

Midas macquarti, Schiner; *M. clavatus*, Macq., l.c., Sup., IV., 59, 7.

ASILIDÆ.

Dasypogon viduus, Walker, l.c., 354.
„ *discus*, Walker, l.c., 358.
Asilus varius, Walker, l.c., 457.
„ *bulbus*, Walker, l.c., 465.
„ *lascus*, Walker, l.c., 466.
Saropogon antipodus, Schiner, l.c., 166.
Itamus melanopogon, Schiner, l.c., 190.

DOLICHOPIDÆ.

Psilopus gemmatus, Walker, l.c., 647.
Stomoxys œnos, Walker, l.c., 1160.

SYRPHIDÆ.

Milesia bilineata, Walker, l.c., 566.
Syrphus novæ-zealandiæ, Macq., l.c., Sup., V., 95, 57.
„ *ortas*, Walker, l.c., 585.
„ *ropalus*, Walker, l.c., 593.
Helophilus trilineatus, Fabr. (?), l.c., 766, 16.
„ *inaptus*, Walker, l.c., 608.
„ *latifrons*, Schiner, l.c., 359.
„ *antipodus*, Schiner, l.c., 359.
Eristalis cingulatus, Fabr., l.c., 767, 23.

MUSCIDÆ.

Aricia melas, Schiner, l.c., 302.
Limnia transmarina, Schiner, l.c., 234.
Sapromyza decora, Schiner, l.c., 277.
„ *sciomyzina*, Schiner, l.c., 278.
„ *dichromata*, Walker, l.c., 988.
Tetanocera sigma, Walker, l.c., 1084.
Opomyza apicalis, Walker, l.c., 1114.
Tachina zelica, Walker, l.c., 711.
„ *orasus*, Walker, l.c., 741.
„ *mestor*, Walker, l.c., 741.
„ *sosilus*, Walker, l.c., 796.
Musca quadrimaculata, Swed., Stock. Nya. Handl., VIII., 289, 49.
„ *hortona*, Walker, l.c., 894.
„ *icela*, Walker, l.c., 897.
„ *taitensis*, Macq., l.c., II., 3, 153, 7.
„ *læmica*, White, Dieff. New Zealand, II., p. 291.
Cænosia spinipes, Walker, l.c., 969.
Dexia rubricarinata, Macq., l.c., Sup., I., 187, 5.
Bothrophora zelebori, Schiner, l.c., 317.
Rutilia leucostica, Schiner, l.c., 319.
„ *pellucens*, Macq., l.c., Sup., I., 177, 6.
Chlorogaster rufipes, Schiner, l.c., 323.
Demoticus australensis, Schiner, l.c., 325.
Hystricia orientalis, Schiner, l.c., 331.
Idia murina, Schiner, l.c., 309.
Cyrtoneura stabulans, Fallen, Muscid., 52, 32 ; Schiner, l.c., 304.
Lamprogaster cærulea, Macq., l.c., Sup., I., 212.
„ *strigipennis*, Macq., l.c., Sup., IV., 290.
Calliphora dasyophthalma, Macq., l.c., II., 3, 130, 8.
„ *aureopunctata*, Macq., l.c., Sup., V., 110, 31.
„ *aureonotata*, Macq., l.c., Sup., V., 115, 3.
Amenia leonina, Fabr., Syst. Ent., 776, 12.
„ *parva*, Schiner, l.c., 316.
Micropalpus brevigaster, Macq., l.c., Sup., I., 149, 6.
Microtropesa sinuata, Donovan ; Macq., l.c., Sup., I., 186, 1.

HIPPOBOSCIDÆ.

Orthinomyia opposita, Walker, l.c., 1145.

NEUROPTERA.

TRICHOPTERA.

Tetracentron sarothropus, Brauer, Ver. Zool. Bot. Geo. Wien, XV., 418.

Tetracentron amabile, M'Lachlan, Jour. Lin. Soc., Zool., 1868, 201.
Olinx feredayi, M'Lachlan, l.c., 198.
Hydrobiosis frater, M'Lachlan, l.c., 207.
" *umbripennis*, M'Lachlan, l.c., 208.
Setodes unicolor, M'Lachlan, l.c., 203.
Polycentropus puerilis, M'Lachlan, l.c., 204.
Pycnocentria funerea, M'Lachlan, Ent. Trans., 3rd Series, V., 252.
" *evecta*, M'Lachlan, Jour. Lin. Soc., Zool., 1868, 200.
" *aureola*, M'Lachlan, l.c., 200.
Leptocerus (?) alienus, M'Lachlan, l.c., 202.
Psilochorema mimicum, M'Lachlan, Trans. Ent. Soc., 1866, 309.
" *confusum*, M'Lachlan, Jour. Lin. Soc., 1868, 210.
Philanisus plebeius, Walker, l.c., 116 ; *Anomalostoma alloneura*, Brauer.
Hydroptila albiceps, M'Lachlan, Trans. Ent. Soc., 1862, 304.
Œconesus maori, M'Lachlan, Trans. Ent. Soc., 1862, 303.
Pseudonema obsoletum, M'Lachlan, l.c., 305.
Notanatolica cognata, M'Lachlan, l.c., 306.
" *cephalotus*, Walker (*Leptocerus*), Cat. Brit. Mus., 73.
Hydropsyche fimbriata, M'Lachlan, l.c., 309.
" *colonica*, M'Lachlan, Jour. Lin. Soc., 1869, 131.

Planipennia.

Chauliodes diversus, Walker, l.c., 205 (*Hermes*).
Myrmeleon acutus, Walker, l.c., 377.
Stenosmylus incisus, M'Lachlan, Jour. Ent., II., p. 112.
Depanopteryx instabilis, M'Lachlan, l.c., p. 115.
" *humilis*, M'Lachlan, l.c., p. 116.
Micromus tasmaniæ, Walker, Trans. Ent. Soc. London, 2nd Series, V., p. 186.

Termitidæ.

Calotermes insularis, Hagen ; Walker, l.c., 521, Sup., 6.
" *improbus*, Hagen ; Brauer, Reise Novara, 45.
Stolotermes ruficeps, Brauer, l.c., 977.

Perlidæ.

Stenoperla prasina, Newman, "Zoologist," 1845, p. 853 (*Chloroperla*); Walker, l.c., II., p. 206 (*Hermes*).
Perla (?) cyrene, Newman, l.c., 853.
Leptoperla opposita, Walker, l.c., 171 (*Perla*).

Ephemeridæ.

Coloburus humeralis, Walker, l.c., 552 (*Palingenia*).
Bœtis remota, Walker, l.c., 564.
" *scita*, Walker, l.c., 570.

Odontata.

Cordulia smithii, White, Voy. Ereb. and Terror, Pl. 6, f. 2 (no description) ; *C. novæ-zealandiæ*, Brauer.
Æschna brevistyla, Rambur, Hist. Névropt., p. 205.
Uropetalia carovei, White, Dieff. New Zealand, II., 281 (*Pentalura*).
Lestes colensonis, White, Ereb. and Terr., Pl. 6, f. 3 (*Agrion;* no description).
Epitheca grayi, Selys, Syn. Cordulines, p. 49.
" *braueri*, Selys, Syn. Cordulines, p. 50.

ORTHOPTERA.

FORFICULARIDÆ.

Forficula littorea, White, Voy. Erebus and Terror, Insects, p. 24.

BLATTIDÆ.

Polyzosteria novæ-zealandiæ, Watt, Blatt., 218.

PHASMIDÆ.

Bacillus hookeri, White, l.c., 24 (*Phasma*).
„ *gerhardii*, Kaup., Proc. Zool. Soc., 1866, 577.
„ *geisovii*, Kaup., l.c., 577.
Acanthoderus horridus, White, l.c., 24 (*Phasma*).
„ *spiniger*, White, l.c., 24 (*Phasma*).
„ *prasinus*, Westwood, Gray's *Phasmidæ*, 49.
Pachymorpha hystricula, Westwood, Cat. Orth. Insects, Pt. I., p. 16.

LOCUSTIDÆ.

Hemideina heteracantha, White, Gray's Zool. Misc., 1842, 78 (*Deinacrida*).
„ *thoracica*, White, Voy. Ereb. and Terr., Pl. 5, f. 2 (*Deinacrida*).
„ *megacephala*, Buller, "Zoologist," 1867, 850 (*Deinacrida*).
„ *capitolina*, Walker, Cat. Locustidæ, p.
„ *abbreviata*, Walker, l.c., p.
„ *producta*, Walker, l.c., p.
„ *tibialis*, Walker, l.c., p.
Hadenœcus edwardsi, Scudder, Proc. Bost. Soc. Nat. Hist., XII., 408.
Ceuthophilus lanceolatus, Walker, l.c., 204.
Macropathus filifer, Walker, l.c., 206.
„ *fascifer*, Walker, l.c., 207.
„ *altus*, Walker, l.c., 208.
Libanasa maculifrons, Walker, l.c., 209.
Hyperomala speciosa, Thunb., Nov. Ins. Sp., V., 286.
Decticus semivittatus, Walker, Cat. Derm. Salt., Pt. II., 263.
Xiphidium maoricum, Walker, l.c., Pt. II., 276.
Agræcia solida, Walker, l.c., Pt. II., 295.

ACRIDIDÆ.

Pachytylus cinerascens, Fabr., Ent. Syst., 59.

GRYLLIDÆ.

Gryllotalpa africana, Pal. Beauv., Ins., 229; Walker, l.c., Pt. VI., p. 4.
Gryllus fuliginosus, Serv., Hist. Orth., 334; Walker, l.c., Pt. VI., p. 42.
Scleropterus maoricus, Walker, l.c., VI., 74.

HETEROPTERA.

PACHYCORIDÆ.

Callidea imperialis, Dallas, Cat. Hemipt. Brit. Mus., 24.

ASOPIDÆ.

Arma schellenbergii, Guer., Voy. Coquille, Zool., II., 166.
Peltophora picta, Guer., l.c., 165.
Cermatulus nasalis, Hope, Cat., 32.

CYDNIDÆ.

Æthus leptospermi, Dallas, l.c., 119.

SCIOCORIDÆ.

Dictyotus polysticticus, Dallas, l.c., 141.

HALIDIDÆ.

Platycoris immarginatus, Dallas, l.c., 154.

PENTATOMIDÆ.

Pentatoma vilis, Walker, Cat. Hemipt. Het., Pt. II., 309.
Rhombocoris similis, Mayr., Verh. Zool. Bot. Gess. Wien, XIV., 912 (*Rhopalimorpha*).
Rhaphigaster prasinus, Walker, l.c., 354.
„ *amoyti*, Dallas, l.c., 278.
„ *pentatomoides*, Walker, l.c., 370.
„ *perfectus*, Walker, l.c., 371.
Rhopalimorpha obscura, Dallas, l.c., 293.
Acanthosoma vittata, Fabr., Ent. Syst., IV., 104, 96.

LYGÆIDÆ.

Lygæus pacificus, Boisduval, Voy. Astrolabe, II., 639.
„ *ruficollis*, Walker, l.c., 65.
Nysius zealandicus, Dallas, l.c., 552.
Plociomerus nigriceps, Dallas, l.c., 577.
Rhyparochromus inornatus, Walker, l.c., 112.

MEMBRANACEA.

Neuroctenus hochstetteri, Mayr., Reise Novara, Zool., II., 166.

REDUVIINÆ.

Reduvius ephippiger, White, Dieff. New Zealand, II., 283.

HOMOPTERA.

STRIDULANTIA.

Cicada cingulata, Fabr., Ent. Syst., IV., 21, 17; Olivier, Enc. Meth., V., 752; Fabr., 680, 9.
„ *zealandica*, Boisduval, Voy. Astrolabe, 611.
„ *sericea*, Walker, Cat. Hom. Brit. Mus., 169.
„ *muta*, Fabr., l.c., 681, 17.
„ *arche*, Walker, l.c., 195.
„ *cincta*, Walker, l.c., 204.
„ *nervosa*, Walker, l.c., 213.
„ *rosea*, Walker, l.c., 220.
„ *indivisula*, Walker, l.c., Sup., 33.
„ *bilinea*, Walker, l.c., Sup., 34.
„ *ochrina*, Walker, l.c., Sup., 34.
„ *cruentata*, Fabr., l.c., 680, 10.

FULGORIDÆ.

Cixius oppositus, Walker, l.c., 345.
„ *punctimargo*, Walker, l.c., Sup., 81.
„ *finitimus*, Walker, l.c., Sup., 81.

Cixius marginalis, Walker, l.c., Sup., 82.
„ *interior*, Walker, l.c., Sup., 82.
„ *apsilus*, Walker, l.c., Sup., 83.
„ *rufifrons*, Walker, l.c., Sup., 83.

CICADELLINA.

Ptyelus fingens, Walker, l.c., 718.
„ *trimaculatus*, White, Ereb. and Terror (not published).

ART. XXXIV.—*List of the Lepidoptera recorded as having been found in New Zealand previous to the Year* 1871. By R. W. FEREDAY, C.M.E.S.L.

IN this arrangement of the New Zealand Lepidoptera I have followed the catalogue prepared for the British Museum by Mr. Butler, "with the view of identifying the species of Diurnal Lepidoptera described by Fabricius by a comparison with the original type specimens, drawings, etc., of referring them to modern genera, and of adding some recent synonyma." The title of the catalogue is "Catalogue of the Diurnal Lepidoptera, described by Fabricius, in the Collection of the British Museum, by Arthur Gardiner Butler, F.L.S., F.Z.S., etc., (1869)."

Order LEPIDOPTERA, Linnæus.

Section RHOPALOCERA, Boisduval.

Family NYMPHALIDÆ, Westwood.

Sub-family SATYRINÆ, Bates.

Argyrophenga, Doubleday.
antipodum, E. Doubleday, Ann. and Mag. N.H., XVI., 307.

The genus *Argyrophenga* is not included in the above catalogue, but is placed in this position in "Cat. Diurnal Lepid. of the Family *Satyridæ* in the British Museum," prepared by Butler for the British Museum, 1868.

Sub-family NYMPHALINÆ, Bates.

Group NYMPHALIDES, Butler.

Pyrameis, Hübner.
cardui, Linn.
gonerilla, Fabr., Syst. Ent., 498, 237.
itea, Fabr., l.c., 498, 238.

Diadema, Boisd.
bolina, Linn.

This species is identical (according to Butler) with *auge*, Cramer, and to the Linnæan name he therefore properly gives precedence.

Sub-family HELICONINÆ, Bates.

Hamadryas, Boisd.
zoilus, Fabr., l.c., 480, n. 163 (1775); Ent. Syst., III., 42, n. 128 (1793).

Family Lycænidæ, Stephens.

Sub-family Lycæninæ, Bates.

Lycæna, Fabr.
oxleyi, Felder.
boldenarum, White.

I cannot give a reference to the description of these species. They are referred to in a paper by Bates on new species of insects from Canterbury, New Zealand, collected by me.—*Vide* Ent. M. Mag., IV., 53.

Chrysophanus, Hüb.
edna, Doubleday.
feredayi, Bates, Ent. M. Mag., IV., 53.

Section HETEROCERA, Boisd.

Tribe SPHINGII, Latr.

Family Sphingidæ, Steph.

Sphinx, Linn.
convolvuli, Linn., var. *g.*, Walker, Cat. Lep. Brit. Mus., part 8, page 212.

Tribe BOMBYCITES, Latr.

Family Leptosomidæ.

Leptosoma, Boisd.
annulatum, Boisd., Voy. de l'Ast., Ent., pl. 5, fig. 9.

Vide Ent. M. Mag., V., 2, where Guenée, in a paper on "New Species, etc., of Heterocerous Lepidoptera from Canterbury, New Zealand, collected by Mr. R. W. Fereday," says:—"This New Zealand species is the true *L. annulatum* of M. Boisduval, and Mr. Walker has erred in transferring that name to the species from New Holland, which differs in the patagia being bordered with white as well as the inner margin of the anterior wings, in the yellow fringe, the spots much less extended, the broader yellow abdominal bands, the yellow face, etc."

Family Siculidæ, Guen.

Morova, Guen.
subfasciata, Walk., l.c., XXXII., 523.

Family Hepialidæ, Step.

Hepialus, Fabr.
despectus, Walk., l.c., XXXII., 594.
characterifer, idem.

Elhamma, Walk.
cervinata, Walk., l.c., XXXII., 595.
signata, Walk., l.c., VII., 1563.
antipoda, Boisduval.

Charagia, Walk.
ingens, Walk., l.c., XXXII., 596.
virescens, Doub., Dieffenbach's New Zealand, I., 284.
rubroviridans, Stephens, MSS.

Porina, Steph.
vexata, Walk., l.c., XXXII., 597.
novæ-zelandiæ, Steph., l.c.

Pielus, Steph.
hyalinatus, Herr Schæff.
umbraculatus, Guen., Ent. M. Mag., V., 1868, 1.
variolaris, Guen., l.c., 1.

Tribe NOCTUITES, Latr.

Division TRIFIDÆ, Guen.

Sub-division BOMBYCIFORMES, Guen.

Family BRYOPHILIDÆ, Guen.

Bryophila, Treit.
temperata, Walk., l.c., XV., 1648.
Declana, Walk.
floccosa, Walk., l.c., XV., 1649.

Family BOMBYCOIDÆ, Guen.

Detunda, Walk.
atronivea, Walk., l.c., XXXII., 618.

Sub-division GENUINÆ, Guen.

Family LEUCANIDÆ, Guen.

Leucania, Ochs.
semivittata, Walk., l.c., XXXII., 628.
extranea, Guen., Noct., I., 77, 104.
„ var. *e.*, var. *a.*, Walker, l.c., IX., 93.
propria, Walk., l.c., IX., 111.
unica, Walk., l.c., IX., 112.
Nonagria, Steph.
juncicolor, Guen., Ent. M. Mag., V., 1868, 2.
Politeia, Walk.
junctilinea, Walk., XXXII., 643.
Ipana, Walk.
leptomera, Walk., l.c., XV., 1662.

Family APAMIDÆ, Guen.

Sub-family EPISEMIDES, Guen.

Heliophorbus, Boisd.
disjungens, Walk., l.c., XV., 1681.

Sub-family APAMIDES, Guen.

Alysia, Guen.
specifica, Guen., Ent. M. Mag., V., 1868, 3.
Mamestra, Steph.
comma, Walk., l.c., IX., 239.

Family NOCTUIDÆ, Guen.

Nitocris, Guen.
bicomma, Guen., Ent. M. Mag., V., 4.
limbosa, Guen., idem, 5.
exundans, Guen., idem.
nuna, Guen., idem, 6.
epiplecta, Guen., idem.
Agrotis, Steph.
moderata, Walk., l.c., XXXII., 705.
suffusa, Steph., Ill. Brit. Haust., II., 116.
admirationis, Guen., Ent. M. Mag., V., 38.
ceropachoides, Guen., idem, 39.
munda, Walk., l.c., X., 348.
cærulea, Guen., Ent. M. Mag., V., 38.
nullifera, Walk., l.c., XI., 742.

Graphiphora, Steph.
implexa, Walk., l.c., X., 405.

Family ORTHOSIDÆ, Guen.

Teniocampa, Guen.
immunis, Walk., l.c., X., 430.
Orthosia, Boisd.
communicata, Walk., l.c., XXXIII., 716.
infusa, Walk., l.c., XI., 748.

Family HADENIDÆ, Guen.

Dasypolia (?), Guen.
dotata, Walk., l.c., XI., 522.
Eumichtis, Hüb.
sisteus, Guen., Ent. M. Mag., V., 39.
Euplexia, Steph.
insignis, Walk., l.c., XXXIII., 724.
Hadena, Guen.
plusiata, Walk., l.c., XXXIII., 742.
pictula (*Dianthecia pictula*, White; Taylor, "Te Ika a Maui," New Zealand, Pl. I, f. 3).
mutans, Walk., l.c., XI., 602.
lignifusca, Walk., l.c., XI., 603.
lignana, Walk., l.c., XI., 758.
nervata, Guen., Ent. M. Mag., V., 40.
Erana, Walk.
vigens, Walk., l.c., XXXIII., 743.
plena, Walk., l.c., XXXIII., 744.
graminosa, Walk., l.c., XI., 605.

Family XYLINIDÆ, Guen.

Xylocampa, Guen.
inceptura, Walk., l.c., XV., 1736.
cucullina, Guen., Ent. M. Mag., V., 40.
Auchmis, Hüb.
composita, Guen., Noct., II., 114, 832.
Xylina, Boisd.
stipata, Walk., l.c., XXXIII., 753.
turbida, idem, 754.
vexata, id., 755.
defigurata, id., 756.
atristriga, id.
canescens, id., 757.
ustistriga, Walk., l.c., XI., 630.
lignisecta, id., 631.
spurcata, id.
inceptura, id., XV., 1736.
deceptura, id., 1737.
provida, id.

Division QUADRIFIDÆ, Guen.

Sub-division INTRUSÆ, Guen.

Family AMPHIPYRIDÆ, Guen.

Bityla, Walk.
thoracica, Walk., l.c., XXXIII., 869.

Family HELIOTHIDÆ, Guen.

Heliothis, Guen.
peltigera, Steph., Ill. Brit. Ent. Haust., III., 109.
armigera, Hübn., Noct., Pl. 79, f. 370.
conferta, Walk., l.c., XI., 690.

Sub-division VARIEGATÆ, Guen.

Walker has called the sub-divisions of the *Quadrifidæ* Tribes, but they should evidently be called sub-divisions, as in the *Trifidæ*.

Family ERIOPIDÆ, Guen.

Cosmodes, Guen.
elegans, Guen., Noct., II., 290, 1092.

Family PLUSIDÆ, Boisd.

Plusia, Ochs.
eriosoma, Doub., Dieff. New Zealand, II., 285.

Sub-division PATULÆ, Guen.

Family OMMATOPHORIDÆ, Guen.

Dasypodia, Guen.
selenophora, Guen., Noct., III., 175, 1566.

Tribe DELTOIDITES, Guen.

Family HYPENIDÆ, Herr Schæff.

Phapsa, Walk.
scotosialis, Walk., l.c., XXXIV., 1149.

Tribe PYRALITES, Guen.

Sub-tribe LURIDÆ, Guen.

Family ASOPIDÆ, Guen.

Daraba, Walk.
extensalis, Walk., l.c., XXXIV., 1311.
Hymenia, Hübn.
recurvalis, Fabr.

Family STENIADÆ, Guen.

Diasemia, Steph.
grammalis, Doub., l.c., 287.
Ischnurges, Ld., Wien Ent. Mon., VII., 418, Pl. 3, f. 14.
illustralis, Ld., Wien Ent. Mon., VII., Pl. 15, f. 12.
See Walker, l.c., XXXIV., 1330.

Family BOTYDÆ, Guen.

Scopula, Schr.
daiclesalis, Walk., l.c., XIX., 1017.
cordalis, Doub., l.c., 288.
flavidalis, id., 287.
quadralis, id., 288.
dipsasalis, Walk., l.c., XVIII., 796.
hybreasalis, id., 797.
paronalis, id.
Mecyna, Guen.
polygonalis, Treits.

According to Dieff., this is the *plygonalis* of Treits.; and the *polygonalis* of Treits. is the *Mecyna polygonalis* of Guen.—See Walk., l.c., XIX., 804.

Sub-tribe PLICATÆ, Guen.

Family SCOPARIDÆ, Guen.

Scoparia, Haw.
diptheralis, Walk., l.c., XXXIV., 1501.
minusculalis, id., 1503.
linealis, id.
minualis, id., 1504.
feredayi, Kuags., Ent. M. Mag., IV., 80.
rakaiensis, id.
ejuncida, id., 81.
exilis, id.

Tribe GEOMETRITES, Newm.

Family ENNOMIDÆ, Guen.

Angerona, Dup.
menaria, Walk., l.c., XXVI., 1500.
Selenia, Hübn.
gallaria, Walk., l.c., XX., 259.
Polygonia, Guen.
fortinata, Guen., Ent. M. Mag., V., 41.
Lyrcea, Walk.
alectoraria, Walk., l.c., XX., 259.
Ennomos, Treit.
ustaria, Walk., l.c., XXVI., 1519.
Ischalis, Walk.
thermocromata, Walk., l.c., XXVI., 1750.
Sestra, Walk.
fusiplagiata, Walk., l.c., XXVI., 1751.

Family BOARMIDÆ, Guen.

Zermizinga, Walk.
indocilisaria, Walk., l.c., XXVI., 1530.
Boarmia, Treit.
dejectaria, Walk., l.c., XXI., 394.
attracta, id.
exprompta, id., 395.
Tephrosia, Boisd.
patularia, Walk., l.c., XXI., 422.
scriptaria, id.
Gnophos, Treit.
pannularia, Guen., Ent. M. Mag., V., 42.

Family ACIDALIDÆ, Guen.

Asthena, Hübn.
ordinata, Walk., l.c., XXII., 676.
subpurpureata, Walk., l.c., XXVI., 1588.
mullata, Guen., Ent. M. Mag., V., 42.
Acidalia, Treit.
(?) *pulchraria*, Doub., l.c., 286; Walk., l.c., XXIII., 781.

This is identical with *Ptychopoda rubropunctaria*, Doub., l.c., 286.—See Walk., l.c., XXIII., 781.

(?) *rubraria*, id.

This is *Ptychopoda rubraria*, Doub., l.c., 286.—See Walk., l.c., XXIII., 781.

prefectata, Walk., l.c., XXIII., 781.

Acidalia (continued)
schistaria, id., 782.
subtentaria, id., XXVI., 1610.
absconditaria, id., 1611.

Family MICRONIDÆ, Guen.

Gargaphia, Walk.
muriferata, Walk., l.c., XXVI., 1635.

Family MACARIDÆ, Guen.

Macaria, Curt.
(?) *humeraria*, Walk., l.c., XXIII., 940.

Family FIDONIDÆ, Guen.

Lozogramma, Steph.
obtusaria, Walk., l.c., XXIII., 985.
Panagra, Guen.
scissaria, Guen., Ent. M. Mag., V., 43.
hypenaria, Guen., Phal., II., 128, 1125.
See Walker, l.c., XXIII., 992.
promelanaria, Walk., l.c., XXVI., 1666.
venipunctata, id.
ephyraria, id.
Fidonia, Treit.
(?) *servularia*, Guen., Ent. M. Mag., V., 43.
(?) *brephosata*, Walk., l.c., XXIV., 1037.
(?) *acidaliaria*, id.
peroruata, Walk., l.c., XXVI., 1672.
Aspilates, Treit.
subocraria, Doub., l.c., 285.
abrogata, Walk., l.c., XXIV., 1075.
euboliaria, Walk., l.c., XXVI., 1684.

Family HYBERNIDÆ, Guen.

Hybernia, Latr.
boreophilaria, Guen., Ent. M. Mag., V., 61.

Family LARENTIDÆ, Guen.

Larentia, Dup.
corcularia, Guen., Ent. M. Mag., V., 62.
infantaria, id.
catocalaria, id.
clarata, Walk., l.c., XXIV., 1197.
productata, id.
megaspilata, id., 1198.
subductata, id.
infusata, id., 1199.
invexata, id.
semisignata, id., 1200.
lucidata, id.
(?) *quadristrigata*, id.
inoperata, id., 1201.
This is *Cidaria* (?) *cineraria*, Doub., l.c., 286.
diffusaria, id.
punctilineata, id., 1202.
interclusa, id.

Eupithecia, Curt.

cidariaria, Guen., Ent. M. Mag., V., 62.
(?) *bilineolata*, Walk., l.c., XXIV., 1246.
muscosata, id.
semialbata, id., XXVI., 1708.
inexpiata, id.
indicataria, id.

Coremia, Guen.

ardularia, Guen., Ent. M. Mag., V., 63.
inamœnaria, id.
ypsilonaria, id., 64.
rosearia, Doub., l.c., 285.

This is *Cidaria rosearia*, Doub., l.c., 285.

robustaria, Walk., l.c., XXV., 1320.
semifissata, id.
plurimata, id., 1321.
deltoidata, id.
pastinaria, Guen., Ent. M. Mag., V., 64.
(?) *inductata*, Walk., l.c., XXV., 1322.

Camptogramma, Steph.

strangulata, Guen., Phal., II., 423, 1586.

See Walk., l.c.. XXV., 1327.

fuscinata, Guen., Ent. M. Mag., V., 92.
stinata, id.

This is printed "*stinaria*" in Ent. M. Mag., but, in the MS. list sent to me by M. Guenèe, who named the species from a specimen received from me, it is written "*stinata*," and the latter agrees best with the termination of the names of the other species.

correlata, Walk., l.c., XXV., 1330.

Dasyurus, Guen.

partheniata, Guen., Ent. M. Mag., V., 93.

Phibalapteryx, Steph.

suppressaria, Walk., l.c., XXVI., 1721.
parvulata, id.

Scotosia, Steph.

subobscurata, Walk., l.c., XXV., 1358.
erebinata, id.
stigmaticata, id., 1359.
panagrata, id., 1360.
denotata, id., 1361.
lignosata, id.
subitata, id., 1362.
humerata, id.

Cidaria, Treit.

inclarata, Walk., l.c., XXV., 1411
perductata, id., 1412.
congressata, id.
similata, id., 1413.
conversata, id.
descriptata, id., 1414.
bisignata, id., 1415.
congregata, id.
aggregata, id.

Cidaria (continued)
pligifurcata, id., 1416.
lestevata, id.
agrionata, id., 1417.
tipulata, id.
inclinataria, id., 1418.
collectaria, id., 1419.
transitaria, id.
rudisata, id., 1420.
(?) *obtruncata*, id., 1421.
flexata, id.
dissociata, id., XXVI., 1734.
similisata, id., 1735.
pyramaria, Guen., Ent. M. Mag., V., 93.
bulbulata, id., 94.
delicatulata, id.
Helastia, Guen.
eupitheciaria, Guen., Ent. M. Mag., V., 95.
Chalastra, Walk.
pellurgata, Walk., l.c., XXV., 1430.
Elvia, Walk.
glaucata, Walk., l.c., XXV., 1431.

Tribe CRAMBITES, Sta.

Family PHYCIDÆ, Guen.

Hypochalcia, Hübn.
submarginalis, Walk., l.c., XXVII., 48.
indistinctalis, id.
Nephopteryx, Hübn.
maoriella, Walk., l.c., XXXV., 1720.
subditella, id.
Gadira, Walk.
acerella, Walk., l.c., XXXV., 1742.

Family CRAMBIDÆ, Sta.

Crambus, Fabr.
flexuosellus, Doub., l.c., 289.
vitellus, id.
ramosellus, id., 288.
nexalis, Walk., l.c., XXVII., 178.
transcissalis, id.
sabulosellus, id.
Eromene, Hübn.
lepidella, Walk., l.c., XXXV., 1761.
bipunctella, id.
auriscriptella, id., XXX., 976.
Samana, Walk.
falcatella, Walk., l.c., XXVII., 197.
Adena, Walk.
xanthialis, Walk., l.c., XXVII., 198.

Tribe TORTRICITES.

Family TORTRICIDÆ, Guen.

Teras, Tr.
punctilineana, Walk., l.c., XXXV., 1780.

Teras (continued)
cuneiferana, id.
(?) *abjectana*, id., 1781.
pauculana, id.
contractana, id., 1782.
excessana, id., XXVIII., 303.
oblongana, id.
inaptana, id., 304.
incessana, id.
spurcatana, id., 305.
biguttana, id.
conditana, id., 306.
servana, id.
semiferana, id.
priscana, id., 307.
antiquana, id.
congestana, id., 308.
(?) *maoriana*, id.
(?) *accensana*, id., XXX., 983.

Pandemis, Hübn.
gavisana, Walk., l.c., XXVIII., 312.

Batodes, Guen.
jactatana, Walk., l.c., XXVIII., 317.

Tortrix, L.
innotatana, Walk., l.c., XXVIII., 333.

Sciaphila, Tr.
flexivittana, Walk., l.c., XXVIII., 353.
transtrigana, id., 354.
turbulentana, id., 355.
fusiferana, id.
detritana, id., 356.
servilisana, id.
spoliatana, id.
infimana, id., 357.
saxana, id.

Olindia, Guen.
(?) *vetustana*, Walk., l.c., XXVIII., 358.

Conchylis, Tr.
plagiatana, Walk., l.c., XXVIII., 370.
leucaniana, id.
recusana, id.
marginana, id., 371.

Pedisca, Tr.
luciplagana, Walk., l.c., XXVIII., 381.
morosana, id., 382.
privatana, id.

Grapholita, Sta.
abnegatana, Walk., l.c., XXX., 991.

Argua, Walk.
scabra, Walk., l.c., XXVIII., 448.

Family CHORUTIDÆ, Sta.

Simaethis, Lch.
combinatana, Walk., l.c., XXVIII., 456.
(?) *abstitella*, id., XXX., 997.

Tribe TINEITES, Newm.

Family TINEIDÆ, Sta.

Tinea, L.

tapetzella, L.

See Walk., l.c., XXVIII., 466.

contactella, Walk., l.c., XXXV., 1813.
rectella, id., XXVIII., 482.
certella, id., 484.
plagiatella, id., 485.
admotella, id.
derogatella, id.
bisignella, id., XXX., 1007.
fusilella, id., 1008.
maoriella, id.

Incurvaria, Hw.

basella, Walk., l.c., XXVIII., 492.

Sabatinca, Walk.

incongruella, Walk., l.c., XXVIII., 511.

Family PLUTELLIDÆ, Sta.

Cerostoma, Ltr.

terminella, Walk., l.c., XXVIII., 548.
fulguritella, id.

Family GELECHIDÆ, Sta.

Gelechia, Zl.

conspicuella, Walk., l.c., XXIX., 651.
innotella, id., 652.
intactella, id.
monospilella, id., 653.
adapertella, id.
adreptella, id., 654.
sublitella, id.
deamatella, id.
flavidella, id., 655.
collitella, id.
convulsella, id., 656.
contextella, id.
contritella, id., 657.
subditella, id.
bifaciella, id.
peroneanella, id., 658.
apparitella, id., XXX., 1027.
copiosella, id., 1028.

Œcophora, Zl.

apertella, Walk., l.c., XXIX., 698.
armigerella, id.
ademptella, id.
picarella, id., 699.
hamatella, id., 700.

Cryptolechia, Zl.

coarctatella, Walk., l.c., XXIX., 768.
colligatella, id.
lichenella, id., 769.

Izatha, Walk.
attractella. Walk., l.c., XXIX., 787.
Tingena, Walk.
bifaciella, Walk., l.c., XXIX., 810.
Vanicella, Walk.
disjunctella, Walk., l.c., XXX., 1039.

Family GLYPHYPTERYGIDÆ, Sta.

Glyphypteryx, Hübn.
externella, Walk., l.c., XXX., 841.
scintelella, id.

Family ARGYRESTHIDÆ, Sta.

Argyresthia, Hübn.
transversella, Walk., l.c., XXX., 849.
stilbella, id.

Family GRACILARIDÆ, Sta.

Gracilaria, Hw.
frontella, Walk., l.c., XXX., 856.
arenosella, id., 857.

Family ELACHISTIDÆ, Sta.

Elachista, Sta.
subpavonella, Walk., l.c., XXX., 898.

Tribe PTEROPHORITES, Latr.

Family PTEROPHORIDÆ, Zl.

Platyptilus, Zl.
falcatalis, Walk., l.c., XXX., 931.
repletalis, id.
Pterophorus, Gff.
innotalis, Walk., l.c., XXX., 945.
deprivatalis, id., 946.
Aciptilus, Zl.
furcatalis, Walk., l.c., XXX., 950.
monospilalis, id.

ART. XXXV.—*Observations on the Occurrence of a Butterfly, new to New Zealand, of the Genus* Danais. By R. W. FEREDAY, C.M.E.S.L.

[*Read before the Philosophical Institute of Canterbury, 2nd January,* 1874.]

IN February last I had the pleasure of receiving from my friend, Mr. F. H. Meinertzhagen, of Waimarama, Hawke Bay, a large handsome butterfly of the genus *Danais,* captured by him at Waimarama on the 31st January last.

Upon comparison the species appears to be identical with that of a New South Wales specimen of *Danais,* in the Canterbury Museum, received from Mr. C. French, of the Botanical Gardens, Melbourne, and labelled by him "*Danais erippus,* N.S.W., supposed to have been introduced. Common Indian and American species."

There is also another specimen of *Danais* in the Canterbury Museum, amongst a collection of Californian Lepidoptera, received from Mr. Edwards, of San Francisco, and labelled by him *Danias archippus ;* and that and the New South Wales and New Zealand species are so alike, that I fail to distinguish any specific difference. That there is a difference between *erippus* and *archippus* we have the authority of Mr. Butler, who had the typical specimens to refer to, and has placed the species apart in the Catalogue (recently prepared by him) of Diurnal Lepidoptera, described by Fabricius, in the collection of the British Museum ; but what the difference is does not appear from the short descriptions of Fabricius and Cramer, quoted by him, and I have no other description to guide me.

I do not find, either in Mr. Butler's Catalogue, or in the Encyclopèdie D'Histoire Naturelle par le Dr. Chenu (the only authorities at hand to refer to), any mention of *erippus* occurring in America, and perhaps Mr. French may have been led to note its being common in America from having compared a specimen of the New South Wales species with a Californian specimen, similar to that in the Canterbury Museum, and failed, as I have, to discover any difference between them.

Assuming that the New South Wales and American specimens are distinct species, I prefer to treat the New Zealand species as identical with that of New South Wales, and adopt the specific name of *berenice* instead of *erippus*—the Fabrician specific name *erippus* having given place to that of *berenice,* Cramer. (See Butler's Cat. Diur. Lep., p. 4.)

From Dr. Hector I have also received a specimen of this butterfly, taken last summer at Hokitika, where he saw it in great abundance ; and, since the capture of the first, Mr. Meinertzhagen has taken several more specimens at Waimarama, and to him I am indebted for the pains he has taken in obtaining for me much valuable information respecting the insect.

He informs me that whenever he has seen the butterfly it has been flying high, but not swiftly, in sunny sheltered places among trees, and settling on them. He also saw it travelling fast over the country along the coast. The first he saw early in November, and the last he took the first week in April. All the Maoris to whom he showed the butterfly said they knew it, and the old Maoris say it is called "kākăhŭ," and is in some years very plentiful. The caterpillar, they tell him, was very plentiful this year, and feeds upon the pollen of the gourd which they grow in that part of the country (Hawke Bay). They are unanimous in saying that the butterfly was there before any white man came, and the Rev. W. Colenso, of Hawke Bay, told Mr. Meinertzhagen that he saw it there many years ago.

Having heard that his neighbour, Mr. Nairn, had been feeding some new kind of caterpillar found in his garden, Mr. Meinertzhagen wrote to him and obtained three pupæ, which he describes as short and stumpy, of a pale green colour, and dotted with gold spots on the edge of the part which covers the wings. The Maori to whom he showed them recognized them as the pupæ of the *Danais.* Unfortunately the rats got at and destroyed them.

Mr. Nairn sent him a coloured sketch of the caterpillar, and said he had made the sketch entirely from memory and was unable to give the exact proportions of the caterpillar or its number of legs; that it had two horns or feelers on its head, and they appeared to be in continual motion. He describes the shrub on which he found the caterpillar as the *Gomphocarpus ovata*, one of the milk-producing plants, and a native of the Cape of Good Hope. The caterpillar is represented in the drawing as black, with the joints of the segments yellow, and some white spots on the head and second segment. Two rather long tentacles or appendages appear to rise and project from the second segment or back part of the head, and a caudal horn from the last segment.

I am not aware of any record of this species of butterfly having been captured before in New Zealand, but, as I have already stated, the Hawke Bay Maoris and Mr. Colenso testify to its appearance in former years.

That the butterfly has been "introduced" into New Zealand, or even into New South Wales (as intimated by Mr. French), seems to me extremely improbable.

If introduced it must have been either purposely or accidentally. That it has been purposely introduced I think no one will credit without some record of such introduction. That it has been accidentally introduced I think equally improbable, and, as to New Zealand, next to impossible, considering the distance it would have to travel over the ocean, and the extraordinary combination of favourable circumstances that must have arisen before it could possibly have become established in such locality.

And why should this butterfly be thought to have been introduced any

more than *Pyrameis itea, Hamadryas zoilus*, or *Diadema bolina* (*auge*, Cramer), the two former of which occur in Australia, and the latter in the East Indies, as well as in New Zealand? I think it far more reasonable to suppose that at some distant time New Zealand and Australia were connected with Asia by the present intermediate islands and other land now submerged, or so nearly connected that winged insects might have passed from the one locality to the other. The identity of many Australian and New Zealand species of insects with species inhabiting China and the East Indies tends to favour such supposition.

The occurrence of *Danais berenice* in New Zealand, after not having been seen in the colony for some years previously, would seem to be analogous to the intermittent occurrence in Britain of *Vanessa antiopa, Colias edusa, Sterrha sacra*, and some other species of Lepidoptera which have not yet been satisfactorily accounted for, although many entomologists think it due to some peculiar condition of climate or other circumstance necessary to the development of these insects, and that they lie dormant in the ova or pupa state until the happening of such condition or circumstance.

Whether the theory of the introduction of this butterfly into Australia and New Zealand has been supported by any argument or evidence I am not aware, but, in opposition to such theory, I would add the following remarks to the arguments I have already used:—

Firstly. As to its introduction purposely.

We have no record of such introduction, and it is not likely that anyone would take the trouble to introduce it.

It possesses no value but as an ornament, and that it would be selected from among so many far more handsome and attractive butterflies is highly improbable.

I know of no instance of successful attempts to introduce a living butterfly from one disconnected country to another, and the ova of butterflies are not readily procured, neither are the larvæ easily reared.

The appearance of the butterfly at Hawke Bay and Hokitika—places so far apart—without any record of its occurrence in intermediate localities, is inconsistent with the theory of its introduction purposely, unless we are to suppose that the introduction was repeated, or that the person introducing it took the trouble of introducing it at both places.

Secondly. As to its introduction accidentally.

The "blown-over" theory entertained by many entomologists with respect to the appearance in England of butterflies rarely seen there, but common on the continent of Europe, cannot be reasonably applied in this case. That a butterfly could be blown over such an expanse of ocean as it must travel over to reach New Zealand seems to me impossible. Even were it strong enough

on the wing to accomplish such a flight, its natural habit of resting at night would cause it to perish in the water. The boldest advocate of such a theory would scarcely venture to assert that a butterfly has been known to, or would under any circumstances, continue its flight at night; and if this butterfly were so introduced, why not other butterflies, and the large hawk-moths so infinitely stronger and swifter on the wing. The tales of clouds of butterflies seen at sea, thousands of miles from land, are as unreliable as those of the sea serpent.

It is possible, but not probable, that it may have come over in some ship; that it may have entered the cabin or settled in some part of the ship, and having remained there during the voyage, been set at liberty in New Zealand.

It is possible, but not probable, that ova, larvæ, or pupæ may have been introduced with some shrub or plant.

Thirdly. As to its introduction, either purposely or accidentally.

Supposing the butterfly, ova, larvæ, or pupæ to be so introduced, it would be necessary, for the propagation of the species, that the butterfly should be an impregnated female; that it should lay its eggs upon its accustomed food-plant, or upon some other plant that the larvæ would eat (and it is well known how difficult it is to induce the young larvæ of a butterfly to accept for food any other kind of plant than that upon which the larvæ of a like species of butterfly are accustomed to feed); that at least two of the larvæ should escape the numerous enemies and dangers to which they are subject, and attain the pupa state; that the pupæ should survive, and in due time produce a perfect male and a perfect female butterfly; that such male and female should copulate; and that the female should survive through all dangers until she deposited her eggs upon the food plant.

ART. XXXVI.—*An Introduction to the Study and Collection of the Araneidea in New Zealand. With a Description and Figures of* Cambridgea fasciata, *L. Koch, from Chatham Island; and also of a New Species of* Macrothele, *Auss.*, M. huttonii, *Cambr.*, *found at Wellington, New Zealand.* By the Rev. O. P. CAMBRIDGE, M.A., C.M.Z.S.

Plate VI.

[*Read before the Wellington Philosophical Society, 22nd September*, 1873.]

I.—SYSTEMATIC POSITION AND GENERAL STRUCTURE.

THE *Araneidea*, or (as distinguished from other Arachnids) *true* spiders, are often popularly included under the general term of *Insects*; it will, therefore, not perhaps be amiss to begin with a diagram showing their position, both in relation to their nearer congeners as well as to the greater groups of the animal world.

ANIMAL KINGDOM.

Branch: i. Radiata, ii. Mollusca | iii. ARTICULATA, iv. Vertebrata.

Class: i. *Aphantopoda | ii. †Condylopoda.

Sub-class: i. Insecta, ii. Myriapoda, iii. ARACHNIDA | iv. Crustacea.

Order: i. Acaridea, ii. Phalangidea, iii. Solpugidea, iv. Scorpionidea | v. Thelyphonidea vi. ARANEIDEA.

Of the whole sub-class *Arachnida*, it will be sufficient to state here that its leading characters are, BODY *divided into two principal parts*—CEPHALO-THORAX and ABDOMEN; ORGANS OF LOCOMOTION, EIGHT; EYES, *when present*, TWO *to* TWELVE, *and simple; in some few cases absent altogether;* RESPIRATION *by means of* TRACHEÆ *or* PULMOBRANCHIÆ, or a *combination of the two.*

Order ARANEIDEA.

This order of the Arachnida is characterized—first, by an undivided cephalo-thorax, which yet shows, by its various converging grooves and furrows, more or less distinctly, the cephalic and thoracic segments (separate in the *Insecta*), of which it is the soldered-up result (Pl. VI., figs. 3, 4, and 16). The abdomen is united to the cephalo-thorax by a narrow pedicle, and terminates with organs for spinning; it is covered with a continuous epidermis, neither (as far as known) annulate, nor segmentate, nor folded, except in two remarkable species—*Liphistius desultor*, Schiödte, and (but partially only) in *Tetrablemma medioculata*, Cambr. Respiration is tracheal as well as pulmo-branchial; the respiratory organs are placed underneath the fore extremity of the abdomen; their position is generally indicated by round or oval scale-like plates, and at the fore edge of each is an almost imperceptible slit or orifice, through which air is admitted to the breathing apparatus (f. 2*m*, and 15*m*).

* Comprising the *Annelides*.

† Corresponding to the *Insecta*, Linn., or *Condylopoda*, Latr.

In some of the Araneidea the spiracular plates are four in number (f. 15*m*, *n*), but for the most part there are only two; where more than two are present it has been found that the posterior pair are connected with *tracheæ*, the anterior ones with *pulmo-branchiæ.* In some few spiders a kind of supernumerary spiracular slit or opening is visible, near to the ordinary one, but not always similarly placed. *Cambridgea quadrifasciata*, L. Koch, as described below, is an instance of this, where, when the spider is looked at in profile (f. 3*p*), it is *above* the ordinary one on each side (see also post, description of Plate VI., f. 2*tt*).

The *Falces*, two in number (f. 5*d*, 16*d*, 3*x*), are one-jointed, and articulated beneath the fore part of the cephalo-thorax; they are generally armed, more or less, with teeth on their inner sides, and each terminates with a moveable curved fang, which, when not in use, is folded down either across the inner side of the extremity of the falx, as with most spiders (f. 5*d*), or backwards along its length as in one family—*Theraphosides* (f. 15*r*); by means of these fangs a poison secreted within the caput is instilled into the wound made by them, proving, no doubt, fatal to the spider's prey, and often nearly so—in the genus *Lathrodectus*—to human beings; for instance, *Lathrodectus katipo*, Ll. Powell, *vide* Trans. N.Z. Inst., III., pp. 56–59; also, F. W. Wright, *id.*, II., pp. 81–84; and W. L. Buller, *id.*, III., pp. 29–34.

The *Eyes* (f. 12, 19)—as at present known—are two, four, six, or eight in number, but by far the larger proportion have eight eyes; two known species alone have four—*Miagrammopes*, Cambr., and *Tetrablemma*, *id.*—and only one species—*Nops*, Macleay—has yet been described with two; the eyes are variously disposed, but always symmetrically on the fore part of the caput—*i.e.*, the cephalic segment—which is generally well defined by an oblique indentation and constriction on either side of the anterior part of the cephalo-thorax (f. 3*r*, 4*b*, and 16*b*). The number and general position of the eyes form one valuable character for the formation of genera, while their relative size is strongly specific.

The *Legs*, eight in number, are articulated to a kind of separate plate (sternum, f. 2*f*, and 15*f*), which forms the underside of the cephalo-thorax; in one genus (*Miagrammopes*, Cambr.) from Ceylon, no sternum, properly so called, exists, the legs being articulated to the continuous underside of the cephalo-thorax.

Except in one or two species the legs are seven-jointed, and variously furnished with hairs, bristles, and spines, each tarsus ending with two or three claws, generally more or less bent or curved, and commonly pectinated, or finely denticulate; these claws are used as hooks, to give a tension to the lines of their snares by holding on and straining upon them. The spines and bristles also are, in many cases, used in the construction of the silken snares, in which spiders entrap their prey; and the males of some species have a

curious row of short closely-set curved spiny bristles along a portion of the upper side of the metatarsi of the fourth pair of legs. The use of this row of bristles (called the calamistrum) is alluded to further on.

The length of the legs in spiders is very various, both actually and relatively, and the differences between them, as well as their armature and terminal claws, furnish valuable characters, often generic and *always specifically* important (f. 10, 17).

The Palpi are two (in many species leg-like) limbs of five, or (counting the basal piece, to which each is articulated) six joints (f. 7, 8, 9). The basal piece, situated immediately behind the falces, forms a *maxilla* (f. 8*y*, and 9*y*) on either side of another piece, the *labium* (f. 2*h*, and 15*h*). This latter is various in form, and always present, except in a new and remarkable spider lately received from Brazil—*Aphantochilus*, Cambr.—in which the labium is wanting, the maxillæ in this instance closing up to each other. Within the labium is another portion of structure—the tongue—to which sufficient attention has not yet been paid by araneologists ; by the aid of this portion no doubt the act of swallowing the juices of insects, when expressed by the falces and maxillæ, is effected. These parts, *falces*, *maxillæ*, *labium*, and *tongue*, thus form the *mouth* of a spider. The *maxillæ* are various in form and size, and, with the labium and general disposition of the eyes, furnish the most tangible, if not the only reliable, characters for distinguishing the genera. The 3rd (cubital, f. 7*v*, 8*v*, 9*v*) and 4th (radial, f. 7*t*, 8*t*, 9*t*) joints of the palpi in the male are (the former often, the latter generally) characterized by prominences, spiny apophyses or protuberances, which furnish some of the strongest and most tangible specific characters in that sex (f. 7*tt*) ; in the female the palpi are simple and quite pediform, generally terminating with a single claw. The last (or digital) joint of each palpus (in the male spider) is generally more or less concave (f. 8*s*), including in its concavity a (sometimes complex) congeries of lobes, spines, and spiny processes (f. 8*o* and 18*o*) capable in some instances of being opened out as by hinges. These are not developed until the spider has come to maturity. Up to this period the digital joint has a tumid and somewhat semi-diaphanous appearance, and, although generally smaller, bears the same general form that it has after maturity.

That these processes, or, as they are termed, *palpal organs*, are intimately connected with the process of reproduction—the fecundation of the female spider—is certain ; but the mode of their efficiency can hardly be said to have been even yet satisfactorily determined. In the female the palpus terminates generally with a single claw, often pectinated ; instances, however, are frequent of the absence of any terminal palpal claw. Between the plates of the spiracles, and close to the fore-extremity of the abdomen on the under side, is placed the external aperature of the female generative organs ; this aperture

(vulva) is of various forms and sizes in different species. In connection with this aperture is frequently a peculiar corneous process—*epigyne* (f. 6*k*)—differing more or less in structure in almost every species yet known, and thus in most species furnishing a tangible and reliable specific character. In a similar situation is the external orifice (exceedingly minute) of the male seminal organs; no external or protrusive process has ever been observed to be connected with them. Experiments on the generation of spiders, made with great care by our distinguished araneologist, Mr. Blackwall ("Report on some recent researches into the structure, functions, and economy of the Araneidea,"—Report of Brit. Assoc., 1844, pp. 68, 69), go to prove conclusively that the seminal organs of the male spider (at least so far as any external use or application is concerned) are in some cases wholly unnecessary for the impregnation of the female, and this has led me to conjecture (hypothetically) that there may be some minute ducts connecting the seminal organs with the alimentary canal through which the fecundating fluid might pass to the œsophagus, and thus be taken from the mouth by the palpal organs. The discharge of the spermatic fluid in birds into the lower intestine, whence it is voided by the vent, has been mentioned to me by a scientific friend as a somewhat analogous case to what I have suggested. This idea has received some support (in fact it was raised first in my mind) by the repeated notice, in several species, of the constant application, by the male, of the digital joint of the palpus to the mouth, between the times of its application to the female organs. These applications were alternate and rapid, and very distinctly made, and no other use was made of the palpi during the whole process of copulation. The question as to the existence of such ducts, as I have supposed might exist between the male seminal organs and the alimentary canal, would be one well worth the attention of insect anatomists living in the tropics, where spiders of large size might easily be procured for dissection, and in adult males the presence of spermatozoa might be sought for in the œsophagus and mouth by means of the microscope. No European spider is perhaps large enough for such an investigation to be prosecuted with much chance of any certain result. Some arachnologists are of opinion that the male spider collects the seminal fluid with its palpal organs from the minute orifice above noted, but I am not aware of an instance in which any spider has been detected in such an employment of its palpi, either during the process of copulation or at any other time, nor, I believe, has any fluid ever been discovered in the palpi. Mr. Blackwall's opinion would seem to be that impregnation is wholly independent of the male seminal organs or of their contents, which is a position contrary to all reason and analogy; but whatever may be the real facts in regard to this, it is certain that the palpi and curious palpal organs of the male spider are actively used in copulation, and afford

good and tangible specific characters, most useful (in fact indispensable) in the determination of species, in many cases where form, colour, and other points of structure present but little reliable difference.* In one instance (*Lycosa andrenivora*, Bl.) I observed frequent acts of copulation (?) between an adult male and female, and in every act there was an embrace which brought the under part of the abdomen of each spider in contact with that of the other, forming a perfect apparent coition between the sexual apertures of the two; in this instance the palpi were not used at all.

An eminent Prussian arachnologist (Herr Menge) has based numerous genera on the form of the several portions of the male palpal organs; but the mere fact of these characters belonging to one sex only, appears conclusively fatal to their adoption as leading characters of genera. The *spinners* of spiders, situated as before observed (f. 2*o*, 15*o*, and 13*r*), are two, four, six, or eight in number, and usually placed in pairs; when a fourth pair is present it is

* At the time of writing the above I had not had an opportunity of seeing two papers by German araneologists, A. Menge (Ueber die Lebensw. d. Arachn., p. 36) and A. Ausserer (Beob. ueber die Lebensw. der Spinnen, p. 194, etc.), in which, as quoted by Dr. Thorell ("On European Spiders," p. 27, note 1), it is stated that "the male spider, before the act of copulation, emits from the sexual aperture, situated under the base of the abdomen, a drop of sperma on a kind of small web made for the purpose, which drop he then takes up in the genital bulb of the palpi."

If this be the usual *modus operandi*, it certainly seems strange that so painstaking and accurate an observer as Mr. Blackwall should never have seen it take place during at least forty years' observations "in the field." I certainly have not myself witnessed any such process, though in some few instances the *whole* act, apparently, of copulation, from its beginning to its conclusion, has come before me. Mr. Blackwall also, in a paper just come to hand (Proc. Lin. Soc., Vol. VII.), and entitled "*A succinct review of recent attempts to explain several remarkable facts in the physiology of Spiders and Insects*," alludes to Herr Menge's solution of the point in question, and also to a conjecture of M. Dugés, offered many years previously; and he mentions a fact observed by himself in reference to a male of *Agelena labyrinthica* which seems to support a part both of Dugés' conjecture and Menge's solution. Mr. Blackwall says that "a male of *Agelena labyrinthica*, confined in a phial, spun a small web, and among the lines of which it was composed I perceived that a drop of white, milk-like fluid was suspended; how it had been deposited there I cannot explain, but I observed that the spider, by the alternate application of its palpal organs, speedily imbibed the whole of it."

Since the above note was penned I have received the concluding part of Thorell's "Synonyms of European Spiders," in which (Part IV., pp. 591–595) Dr. Thorell reviews most of the above among other considerations upon this interesting subject. It appears that a German araneologist, Herman, of whose writings I was ignorant, had in 1868 concluded that there was some communication by a duct, or ducts, between the spermatic vessels in the abdomen and the palpal organs. This idea seems to be negatived by former anatomists (Dugés and others), who have failed to discover any duct *in the palpus*, where it should, if existant, be of comparatively easy discovery; but their failure to discover more than two flexuose vermicular spermatic vessels in the abdomen does not convince me that other—may-be excessively minute but efficient—ducts may not be there, and so connect these tubes (through the stalk which contains the alimentary canal, and joins the cephalo-thorax and abdomen) with the œsophagus, as mentioned above.

generally as a single one united throughout its whole length, and occupying a transverse position in front of the rest. It is but lately that spiders have been observed with *two* spinners only ("Spiders of Palestine and Syria," by O. P. Cambridge, Proc. Zool. Soc., 1872, p. 260; also, An. N. H., 1870, pp. 414–417, *ibid.*)

The spinners vary greatly in size and structure, as well as in number, but hitherto their use in classification has not been what one might have expected from so essential and important a portion of structure. The *fourth* pair of spinners, when present—which it is in both sexes—is correlated, but only in the female sex, with the peculiar double series of closely-set curved bristles (mentioned above) on the metatarsi of the fourth pair of legs. Mr. Blackwall has given the appropriate name of *calamistrum* to this series of bristles, and has proved that their function is to card or tease a peculiar kind of adhesive silk secreted and emitted from the fourth pair of spinners—the use of the silk is for disposal about the spider's snare, rendering the entanglement of its prey the more speedy and certain. Immediately above the spinners is a small nipple-like prominence, of greater or less size, which indicates the orifice of the anus (f. 15*p*).

As it does not enter into the design of this short introduction to go into the anatomical details of the Araneidea, it remains only to touch briefly upon their distribution and habits, and to make a few observations on their capture and mode of preservation.

It should, however, be noticed here that the sexes of spiders, though not generally presenting any *great* difference in size, yet in very many cases show it to an extreme extent. The male is nearly always the smallest, though its legs are often much the longest, but with many of the Epeïrides and Thomisides the male is scarcely more than an eighth or a tenth of the length of the female. This is a fact to be borne in mind, otherwise the male of many such spiders will be overlooked, or thought to be of a different species, while, if it is remembered, the collector may often have an opportunity of noting important circumstances in the economy of spiders which at first sight may seem to be unconnected with each other; and thus spiders now perhaps described as totally different species may be found to be the different sexes of the same.

In determining the species of spiders it is very convenient to obtain comparative dimensions from different portions of structure; thus the position of the eyes on the fore part of the caput furnishes us with the *facial space* (f. 5*e*, and 19*a*), and the *clypeus* (f. 3*n*, and 19*b*). The comparative extent of these parts is of great importance as a specific character, and they are of easy observation; that part of the facial space occupied by the eyes is concisely expressed by the "*ocular area*" (f. 3*o*).

II.—DISTRIBUTION AND HABITS.

Spiders are to be found more or less abundantly in every part of the world, and in almost every conceivable position; even subterranean caves, such as those of Adelsberg and the Island of Lesina, are tenanted by species peculiarly adapted, by the absence of eyes, to their dark and gloomy abodes. Less repulsive in appearance than most others of the Arachnida, the Araneidea are often extremely interesting in their habits. Being almost exclusively feeders on the insect tribes, they are consequently endowed with proportionate craftiness and skill; this is shown remarkably in the construction of their snares and dwellings, and though many live a vagabond life, and capture their prey without the aid of any snare, by merely springing upon it unawares, or, in some instances, running it fairly down in open view, yet craft and skill are equally apparent whatever be their mode of life and subsistence.

Spiders are oviparous, and the cocoons or nests in which many species enclose their eggs are very beautiful, as well as varied and characteristic in form. The geometric webs of the Epeïrides are a marvel of beauty and delicacy. The well-known but, as yet, very insufficiently studied nests of the "trap-door" spiders—*Cteniza*, *Nemesia*, etc.—strike even those who have the greatest aversion to spiders with wonder; and the egg cocoon of a not unfrequent spider in England, *Ero variegata*, could hardly fail to arrest the attention of the least concerned in natural history. This cocoon is of a pear shape, formed of strong silk net-work, of a yellow-brown colour, and attached to stems of dead grass, or sticks and other substances, in shady places, by a long elastic stem or pedicle of the same material; it is semi-diaphanous, and the eggs may be seen within like little seeds, but unattached to each other. From their mode of life spiders attain (as we should naturally suppose) their largest size, and are found in greatest profusion, in the tropical regions; while in more temperate climates, where the members of the insect tribes are smaller, and their species fewer, we find spiders in general of comparatively smaller dimensions and less numerous in species. The largest known spider—one of the family Theraphosides, found in Brazil, *Eurypelma klugii*, Koch—has an extent of legs equal to nine inches, with a body (cephalo-thorax and abdomen) of two and a-half or more inches in length; while the smallest known spider —*Walckenäera diceros*, Cambr., found in England—has a body of no more than one twenty-fifth of an inch in length. Tropical countries, however, although possessing the giants of the spider race, are far richer in minute species than has been generally supposed. I have received numerous species from Ceylon, measuring from one-twelfth to one-twentieth of an inch only in length.

To say that spiders are less repulsive in appearance than other Arachnida is to do them but scanty justice, for numbers of species of various genera,

notably amongst the jumping spiders (Salticides), are unsurpassed by insects of any order, in respect both to brilliancy of colouring and the designs formed by its distribution. Some of the curious and delicate little species of the genera *Argyrodes* and *Ariamnes* are perfect marvels of metallic brilliancy—one of the latter (yet undescribed) from Ceylon, has the abdomen of a delicate yellowish-buff hue, covered thickly with separate and nearly round spots or scales of a transparent kind of silvery substance, looking like a compound of silver and mother-of-pearl. Colours and markings, although at times liable to mislead, are yet nearly always specifically characteristic, and should therefore be carefully noted before they had faded, or, as is often the case in preserved specimens, run one into the other.

Besides their craft and skill, spiders are also very cleanly in their habits and persons. I have several times watched one of our common English Saltici—*Calliethera histrionica*, Koch—engaged for many minutes in brushing and cleaning its forehead and eyes with its hairy palpi, just in the way that a cat acts with its fore-paws for a similar purpose. Many spiders show great attachment to their eggs and young; the female *Lycosa* will do battle for her egg-cocoon until apparently convinced of the uselessness of continuing her attempts to regain it. Many, also, of the genus *Clubiona*, as well as others, brood over and tend upon their young, until growing up they disperse to find their own means of subsistence. It is not meant, however, that the young are fed by the parent, for very young spiders probably exist almost solely for a time on the moisture imbibed from the atmosphere, though at a very early age young Epeïrides may be seen catering for themselves among the smaller prey of insects caught in the parental snares.

III.—MODE OF SEARCH AND CAPTURE.

With regard to the search for spiders and their capture, it might almost be sufficient to say *search everywhere*, and *capture in every possible* or *practicable way*; but still it may be useful, as the result of experience, to make a few more detailed remarks upon those heads. There is scarcely any conceivable locality but what some species or other of spiders may be found in it, and, therefore, none should be set down *à priori* as unlikely, or not worth a close examination; among many other favourable localities, however, may be mentioned particularly *loose bark of trees*, under which numerous species conceal themselves by day, and many others dwell entirely, forming underneath it their snares and egg cocoons; *beneath stones* and *detached pieces of rock* myriads of spiders dwell; in this habitat are found many of the Drassides, a numerous and, though generally plainly coloured, exceedingly interesting group; *among rubbish* and *heaps of débris, wood, brickbats*, or what not, *beneath* and *among cut grass* and *rushes* or *reeds* which have lain some little time after cutting, also

among grass or other herbage, *near its roots,* numerous species—seldom to be seen and rarely procured elsewhere—live and secrete themselves; also, among *mosses, lichens,* and *dead leaves* may be found many minute spiders not to be obtained except by a careful search among such materials. *Water-weeds* and *débris,* collected in *marshes* or on the *borders of ponds and streams,* are also most favourable for the hiding places and habitations of many peculiar species seldom found in other localities. I have not mentioned such obvious habitats as trees, bushes, blossoms of flowers, the general surface of the earth, rocks and stones in every locality, houses and old buildings of all kinds, outer walls of houses, palings, tree trunks, etc , etc. ; in all these spiders force themselves upon the collector's attention, but, in the others before-mentioned, they must be searched for carefully, and often painfully. Some spiders again (though of small size) are *quasi-parasitic,* living on the outskirts of the webs of larger species. Those at present known consist of a single genus, or perhaps two genera, of which several species have been described, and others are known. They are of the genera before-mentioned—*Argyrodes* and *Ariamnes.* These inhabit the webs of large Epeïrids, and appear to live on the smaller insects caught in them ; probably also spinning their own irregular snares among the larger lines of the geometric web. The webs, therefore, of large Epeïrids, especially of those which live in colonies like the *Epeïra opuntiæ* of Europe and Asia, should be searched very narrowly for these curious and beautiful little spiders, otherwise they, as well as their long-stemmed pear-shaped nests, will probably be overlooked, or perhaps considered to be only the young of the Epeïrides in whose web their domicile has been taken up. All the known species of this little parasitic group are more or less metallic in their colours and markings; their legs are long and very slender ; the cephalo-thorax of the male is generally very remarkable in its conformation, and the abdomen also frequently takes some eccentric shape.

The search for spiders has this advantage over that for insects in general: spiders cannot escape by taking wing, though I have more than once lost a valuable but minute specimen which has floated away from me successfully on its silken line ; but for the very reason that spiders are more sedentary, or often moving only on the surface of the earth, it requires perhaps greater diligence and attention to become a very successful collector of spiders than of insects. One rule the collector should observe as much as possible, and that is, not to capture spiders with the fingers if it can be avoided, for some spiders in tropical countries will inflict severe injury by their poisonous fangs, and others, especially minute ones, will receive injury to the delicate spines, as well as to the hairs and pubescence, upon which much of their colour and specific character often depends. At times, of course, where it is a question between losing and obtaining a specimen, the fingers must be used ; and practice makes

perfect even in this mode of capture. It is often impossible to capture minute spiders quickly without wetting the finger and laying it lightly upon them. The spider adheres for an instant, during which the finger is applied to the open mouth of a bottle of spirits carried in the pocket, and the spider is at once immersed. When a spider is seized in the fingers it should always be an endeavour to get hold of it by at least two legs, for one leg would most probably be thrown off by the muscular power which spiders can exert at will, provided they have sufficient free motion. Collectors often complain of the brittleness of spiders' legs, but in most cases it results from the instinct of self-preservation, which teaches the spider to give up something rather than lose all. I have seldom found that spiders can throw off their limbs if held by two of them at once. An easy and good way of capturing spiders at rest is with a pill-box; the bottom in one hand and the lid in the other encloses them quickly and safely; for spiders running on the ground, or on walls or trunks of trees, an ordinary entomological hoop-net is most useful. The net is placed (if on the ground) in front of the spider, and with the disengaged hand it is easily guided or driven into the net, whence it must be boxed into a pill-box, like an insect. If the spider is on a wall (no easy place to capture a spider by any other means) the net is held underneath, and then with a twig in the other hand it is dexterously jerked or flipped off into the net. The moment a spider is seen on a wall, or tree trunk, or other similar situation, the net should immediately be placed beneath it, as many spiders drop off the instant that danger even approaches, and would probably be lost entirely if there were bushes or herbage, or rocky and broken ground below. The hoop-net is also most useful for beating bushes and boughs of trees into; but perhaps for this purpose, and for shaking moss, cut grass, and *débris* into, nothing is superior, or in fact equal, to a very large common (but strong) cotton umbrella—a regular Sarah Gamp. The hoop-net is, however, the best for sweeping amongst long grass, rushes, or herbage of every kind, for upon such spiders usually abound. Spiders which spin a geometric web very often live in it, or close by, and yet can seldom be secured unless as a preliminary the net or umbrella be placed well underneath before the examination of the web is begun, but by taking this precaution the tenant usually drops in and is secured at once.

According to some or other then of the above modes of capture, the spiders will be safely secured in pill-boxes of various sizes—but *never* more than one spider in a box, for obvious reasons; a drop or two of chloroform, allowed to run inside the very slightly opened lid, stupefies the inmate in a few moments, when it may be minutely examined, its colours noted, etc., etc., and then dropped into the wide mouthed bottle of spirit of wine carried in the pocket or tied to the button-hole by a short string. To preserve an accurate record of localities, etc., it is perhaps advisable to write a memorandum in pencil on

the lid of the pill-box at the time of capture, and to defer chloroforming and putting into spirits until the day's collecting is over, when notes may be entered from the lid of each box into the note-book at leisure. The spiders can then also be placed in separate tubes or portions of tubes of spirit, divided from each other by a small dividing layer of cotton wool, and each with a little number written on parchment, and slipped into the tube with it, referring to the numbered notes in the note book or collecting journal. In absence of chloroform, brimstone will stupefy spiders, or they may be placed over (but not in) boiling water. Spiders again may be (like Coleoptera) collected into a wide-mouthed bottle in which chopped laurel leaves or blotting paper slightly saturated with prussic acid have been placed, from which they can be removed and placed in spirit at the end of the day. Spiders of large size, especially those with soft and tumid bodies, preserve their form and colours best if kept prisoners for a few days without food in the pill-boxes; during this time they discharge a great deal of the crude contents of the abdomen, which would have rendered their ultimate preservation, even in spirit, doubtful.

IV.—MODE OF PRESERVATION AS CABINET OBJECTS.

Beautiful as are the colours and markings of numbers of spiders, especially of those found in the tropics, yet it is not easy to make good-looking, sightly cabinet objects of the Araneidea; and hence, perhaps, more than from any other cause, this order is, in comparison with the insect orders, almost wholly neglected. It is possible, however, to display a large proportion of them very satisfactorily, if care and dexterous manipulation are used. This may be effected in more than one way. Many species, whose abdominal integument is strong, and pretty thickly clothed with hairs, or hairy pubescence, may be pinned, dried, and set out like insects; the abdomen may in some cases be simply opened from beneath, and after the contents are extracted stuffed with the finest cotton wool; others may have the abdomen inflated with a blow-pipe after its contents have been pressed out, and then rapid drying prevents the obliteration of colour and markings. But the best way to preserve both colour, markings, and form, for scientific purposes (and with some little extra care and trouble, for cabinet objects also), is to immerse and keep them in spirit of wine, or other strong spirit. The late Mr. Richard Beck, of 31, Cornhill, London, communicated to me a method of preserving spiders in spirit, by enclosing them within a flat under-glass and a concave upper one, the two being cemented together with gold size. The spider has to be set out (in spirit) in a natural position, until the limbs are tolerably rigid; it is then laid on its back in a thin concave glass, like a watch glass—this glass must be sufficiently large just to receive legs and all without cramping them, and deep enough to allow the spider just to be free, when a flat glass is laid on the

concave one. When the spider is laid in such a glass on its back, the glass is as nearly as practicable filled with spirit, and the flat glass which may be square and a little larger all round than the other, is *sized* down upon it. The spider may then be seen in every direction, and it looks, in fact, like a living creature swimming inside. The objections to this mode are its comparative costliness, and the impossibility of avoiding the inevitably enclosed air-bubble; as regards the latter, however, its presence might be rendered harmless by slightly tilting the whole in the cabinet drawer; this fully presents the spider to the eye, and frees it also from contact with the air-bubble. Spiders, however, so preserved are sealed up from all higher scientific purposes, such as the minute examination, under a strong lens, of special portions of structure, and their often necessary dissection.

Another mode, which I have practised successfully myself, is far easier, less costly, and leaves the spider free for any scientific investigation, while it is yet made a pleasing object for ordinary observers. My *modus operandi* is first to catch the spider in a pill-box; it is then rendered motionless in a minute or two by a few drops of chloroform allowed to run into the box through the slightly opened lid; when perfectly insensible it is set out and secured in a natural position on a piece of wood or cork, by means of pins placed wherever needed (except *through* any part of the spider); the whole is then placed in a shallow jar, deep enough, however, to allow of sufficient spirit being poured in to cover the spider completely; the jar is then covered over, and allowed to remain undisturbed until the limbs have become sufficiently rigid, by the action of the spirit, to allow of the removal of the pins without affecting the natural position of the spider; this will take place in a week or ten days, more or less, according to circumstances; the longer it is allowed to remain, the less chance there is of the legs curling up afterwards. When removed, after the limbs have become rigid, the spider is put carefully, with the fore-legs downward, into a test-tube just large enough to admit it freely, without unduly compressing the legs, the tube having previously had a slip of white card-board inserted into it, exactly the width of the diameter of the tube, and about three-fourths of its length; this slip of card is to form a back-ground to the spider, and to keep it steadily in one position; the tube is then filled perfectly full of clean spirit of wine, a parchment label containing the name of the spider is inserted in an inverted position, so as to coil round next to the glass, just above the spider, and the tube's mouth is pretty firmly stopped with a pledget of cotton wool, after which it is placed, wool downwards, in a broad-mouthed, glass-stoppered bottle, large enough to contain from five to fifteen, or so, tubes, when ranged within in a single row close to the glass, and kept in place by the whole vacant centre being firmly filled in with cotton-wool; the glass-stoppered bottle thus packed, is then filled up nearly to the brim

with spirit, making it impossible for that in the tubes to evaporate until the whole of that in the bottle has evaporated, which, if the glass-stopper fits pretty well, will not be for several years. In each tube two or more specimens —male and female—may be placed, one above the other, according to the length of the tube, and some specimens are placed so as to shew the upper, and others to shew the under-side. When bottles so filled are arranged on narrow shelves not too far from the eye, they have a very neat appearance, and allow the spiders to be seen through the two glasses easily and perfectly—of course, the bottle must be taken in hand to examine the contents at all closely, and must be turned round to bring those spiders on the opposite side into view. For critical purposes, any tube may be taken out, and the spiders themselves removed from the tube without injury or difficulty, and as easily replaced; it is only necessary to use a pair of fine pliers with which to handle the specimens, and a pair of longer and larger ones, with oval cork or silk-padded points, with which to put in the tubes or remove them from the bottles. The label with the spider's name on it can be easily read through both the tube and bottle, if put in so as to coil closely round the inside of the former, which is, with very little practice, a simple matter to effect. The advantage of having the label *inside* is obvious; for it cannot then be rubbed off by external friction, and it can be removed and replaced at pleasure.

After many trials of different ways of managing test-tubes of spirit in which spiders have been placed, I can at last pronounce the above plan to be almost entirely satisfactory. When stopped with corks, and laid or kept upright in drawers, the spirit was quickly and constantly evaporating, requiring frequent re-filling; besides which, the corks soon became rotten with the action of the spirit, and not only allowed that in the tube to evaporate, but also, often breaking in removal, caused considerable trouble, and sometimes damage to the specimens, in getting out the portion left in the tube. Another evil has also vanished by the use of wool pledgets instead of corks, and that is, the occasionally serious cuts to the fingers from the sudden breakage of the tubes in corking. As the greater part of my own collection is intended for purely scientific purposes, I only take the trouble to set out here and there a specimen for the delectation of unscientific or "goodness gracious" friends; for when set out they occupy, of course, far more space in a tube than when put in just as they happen to come out from the effects of the chloroform or other stupefying agent. A single tube will often thus contain up to twenty or more examples unset, but never more that one species in a tube, and often only one sex. In all cases the name of the species, or a number written on parchment, should be placed in each tube, as above described. Glass-stoppered bottles, containing inverted wool-stopped tubes of unset spiders, may be filled quite full of the tubes, since there is no object in

merely ranging them round next to the glass, as recommended when the spiders are set out in a natural posture; any tube must therefore, in this case, be taken out before the contents can be examined. The numbers and names, however, of the spiders contained in the bottle are known at a glance, by being written at length on a paper, and gummed upon one side of the bottle, and so, being turned outwards on the shelf, it is legible without any necessity of handling. The sizes of the test-tubes and outer bottles required will vary. I am now using (and finding more handy and convenient than any others of the latter) strong, wide-mouthed phials (corked, but of course glass-stoppered ones would be preferable, though much more costly) of the following sizes:—$\frac{1}{2}$oz., 1oz., 2oz., and 4oz.; these are kept in stock by most chemists'-bottle dealers, and may be had at a very reasonable price. The tubes vary from an inch and a half long, and from the size of a large straw mote to three inches long, and these are not too large to go into the mouths of the 2oz. and 4oz. bottles, but are yet large enough to contain the largest tropical spiders, except the comparatively few giants of the families Theraphosides, Thomisides, and Epeïrides; these latter may be put into the bottles without the intervention of any tube. When thus preserved, and arranged on narrow shelves, according to their systematic position, a collection of spiders is by no means an unsightly object, and its contents are almost as easily got at for reference and examination as the contents of most insect cabinets.

Description of the two Spiders, Macrothele huttonii, *sp. n., and* Cambridgea fasciata, *L. Koch, selected to illustrate the structural details given in the foregoing pages.*

Family THERAPHOSIDES.

Sub-family *Theraphosinæ.*

Genus *Macrothele,* Auss.

Diplura, Koch ad part.

M. HUTTONII, sp. nov.

(Plate VI., figs. 14—19.)

I have been induced to describe and figure here the above species (*M. huttonii*) as not only illustrating well the different structural points of spiders noted in the foregoing pages, but also as itself being a spider of an entirely different type of form and structure from *C. fasciata* (described post). It is, as far as I can ascertain, of an undescribed species, and it is with much pleasure that I have connected it with the name of Capt. Hutton, from whom I received it, and to whom I am so deeply indebted for many other valuable and interesting examples of New Zealand spiders.

The following is a detailed description of *M. huttonii*:—

Adult male; length, 8·5 lines.

Cephalo-thorax broad oval, slightly squared (or truncate) at each end, depressed above, with but slight hinder slope, and little lateral compression forwards; the normal furrows and indentations are strongly marked; that indicating the junction of the caput and thoracic segments is large, deep, and of a circular form. It is of a clear and uniform yellow colour, with some marginal rows of short, and not very strong, dark hairs; a few of the same are also on the hinder slope, and a single row runs from between the eyes of the hind central pair to the thoracic junction.

The *Eyes* are on a very slight eminence close to the fore margin of the caput (the height of the clypeus being equal to the diameter of one of the four central eyes), and are in a position common to numbers of the Theraphosides. They are in two curved rows, or perhaps they may be better described as follows: two round, dark-coloured ones occupy the middle of the fore part of the slight eminence mentioned; these are separated by an interval of rather less than the diameter of one of them, and on either side is a group of three other eyes of a pearl-white colour, in a triangular form; but though rather close to the round eye on its side, and to each other, they are none of them contiguous with the other. Looking at the eyes as in two transverse rows, the two hind centrals are wide apart, the interval being nearly equal to the length of the line formed by those of the fore central pair; the form of the hind centrals is also somewhat quadrate; that of the eyes of the lateral pairs is oval. The fore laterals are largest, obliquely situated, and each is separated from the fore central nearest to it by an interval equal to that which divides it from the hind lateral on its side, which is also oblique, and very near to, but not contiguous with, the hind central nearest to it.

The *Legs* are strong, and moderately long, but not greatly differing in length—apparently their relative length is 4, 3, 1, 2. Those of the first pair are much the strongest, and have the tibiæ and metatarsi inordinately developed; the former are of large size, and somewhat oval, tumid form, and are armed with numerous not very long, but strong, bluntish-pointed black spines beneath the fore extremity, and on the inner side. The metatarsi are strongly bent downwards, and have a somewhat angular enlargement beneath their fore extremity. The legs, generally, are armed with spines, and furnished pretty thickly with hairs; each tarsus ends with three claws, but there is no scopula beneath them, which negative character appears to be the only good distinction from the genus *Diplura*, Koch. The colour of the foremost pair is a deep, rich reddish, chestnut-brown; the rest are of a greenish yellow-brown, the different joints, except the tarsi and metatarsi, being longitudinally banded with a darker hue.

The *Palpi* are moderate in length and strength; they are of a greenish yellow-brown colour, and furnished with long hairs chiefly on the radial

joints. The radial is about double the length of the cubital joint, and decreases a little in strength gradually from its hinder to its fore extremity. The digital joint is of a somewhat oval form, broadest in front, where it is notched or strongly indented. The palpal organs consist of a simple pyriform corneous bulb, its stem tapering to a point, curved, and directed outwards and backwards.

The *Falces* are moderate in strength, roundly prominent, and of rich chestnut-brown colour, furnished with bristly hairs in front.

The *Maxillæ* are strong and divergent, the extremity of each, on the inner side, is slightly produced into an obtusely prominent point.

The *Labium* is short, and of a somewhat semi-circular form. These parts are of a brownish-yellow colour.

The *Sternum* is not large ; it is broader behind than at its fore part, hairy, and of a greenish yellow-brown colour.

The Abdomen is rather large, oval, and moderately convex above ; it is of a blackish-brown colour, mottled and marked with pale whitish drab-yellow, and an indistinct pattern may be traced showing a longitudinal central tapering dark bar, from which on either side several broadish, pale, and slightly oblique bars run off to the sides. The upper-side is furnished with numerous long tapering bristly hairs, each springing from a minute black spot. The four large spiracular plates on the under-side are yellow, with a large patch of black brown on each. The spinners are four in number ; those of the superior pair are tapering, nearly as long as the abdomen, and consisting of three joints of nearly equal length ; they are hairy, and of a greenish yellow-brown colour. Those of the inferior pair are small, one-jointed, and not more than half the length of a single joint of the superior pair.

An adult female agreed substantially with the above description of the male, except in being rather larger and wanting the abnormal form and development of the tibiæ and metatarsi of the legs of the first pair, and, of course, differing also in the structure of the palpi, which, in this sex, are simply pediform, and terminate with a single strongish, rather blunt-pointed, curved claw, armed beneath with (apparently) a single tooth towards its base.

An adult of each sex of this spider was received from Captain F. W. Hutton, by whom they were found at Wellington, New Zealand.

Family AGELENIDES.

Sub-family *Argyronetinæ*

Genus *Cambridgea*, L. Koch.

C. FASCIATA.

Cambridgea fasciata, L. Koch, Die Arachniden Australiens, pp. 358—361, pl. XXVIII., fig. 2.

(Pl. VI., figs. 1—13.)

An adult female of this spider was contained in a small collection made in

Canterbury, New Zealand, several years ago, and kindly given me by Dr. Ll. Powell, of Christchurch, N.Z. In a subsequent collection from Waikato, N.Z., kindly sent by Captain Hutton, there were one or two others (females also) of the same species. Upon one of these (a very small example) the above new genus was founded by Dr. L. Koch, to whom I had transmitted the specimen for examination. More recently still, Captain Hutton has forwarded me an adult male and female of it found by Mr. H. H. Travers at the Chatham Islands, N.Z. The adult male nearly resembles the female in colours and markings, but is very much larger than either of the females I have yet seen, and differs from them notably in the development of the falces; in fact, the whole spider affords such a good example of the different points of detail in the general structure of the *Araneidea*, that I have decided to figure it in the present instance for the purpose of illustrating the structural features of spiders remarked upon in the previous pages.

With regard to the genus *Cambridgea*, founded upon this species by Dr. L. Koch, I was at first rather doubtful myself as to its distinctness from *Argyroneta*, Latr.; as, however, that able author still adheres to his opinion on the point, I have given this spider here under the generic name which he has done me the honour to confer upon it, though not having myself yet been able to compare it critically with *Argyroneta*. The following are the measurements of the different examples that have as yet come under my notice :—

Female adult (type of genus and species), Waikato, N.Z.; length, 3·5 lines.
" " " " Waikato; length, 5 lines.
" " " " Canterbury; length, 7 lines.
" " " " Chatham Is.; length, 8·5 lines.
Male adult " " " Chatham Is.; length, 10·5 lines.

This great variation in size is also a strong character in the genus *Argyroneta;* as also are the development of the falces in the male, and the existence of the supernumerary spiracular orifices indicated in f. 2*tt*., and f. 3*p*.

The following is a detailed description of the male :—

Cephalo-thorax oval, moderately convex above, constricted laterally forwards, and rather truncate at its fore extremity; it is of a light reddish-yellow brown colour, with a broad lateral band of a much deeper hue on either side, and also a similar longitudinal central one, divided almost throughout its length by a fine light reddish-yellow line. The height of the clypeus, which is nearly vertical, is less than half the facial space; the surface of the cephalo-thorax is thinly clothed with fine adpressed light-coloured hairs, with a few prominent bristles in the ocular region.

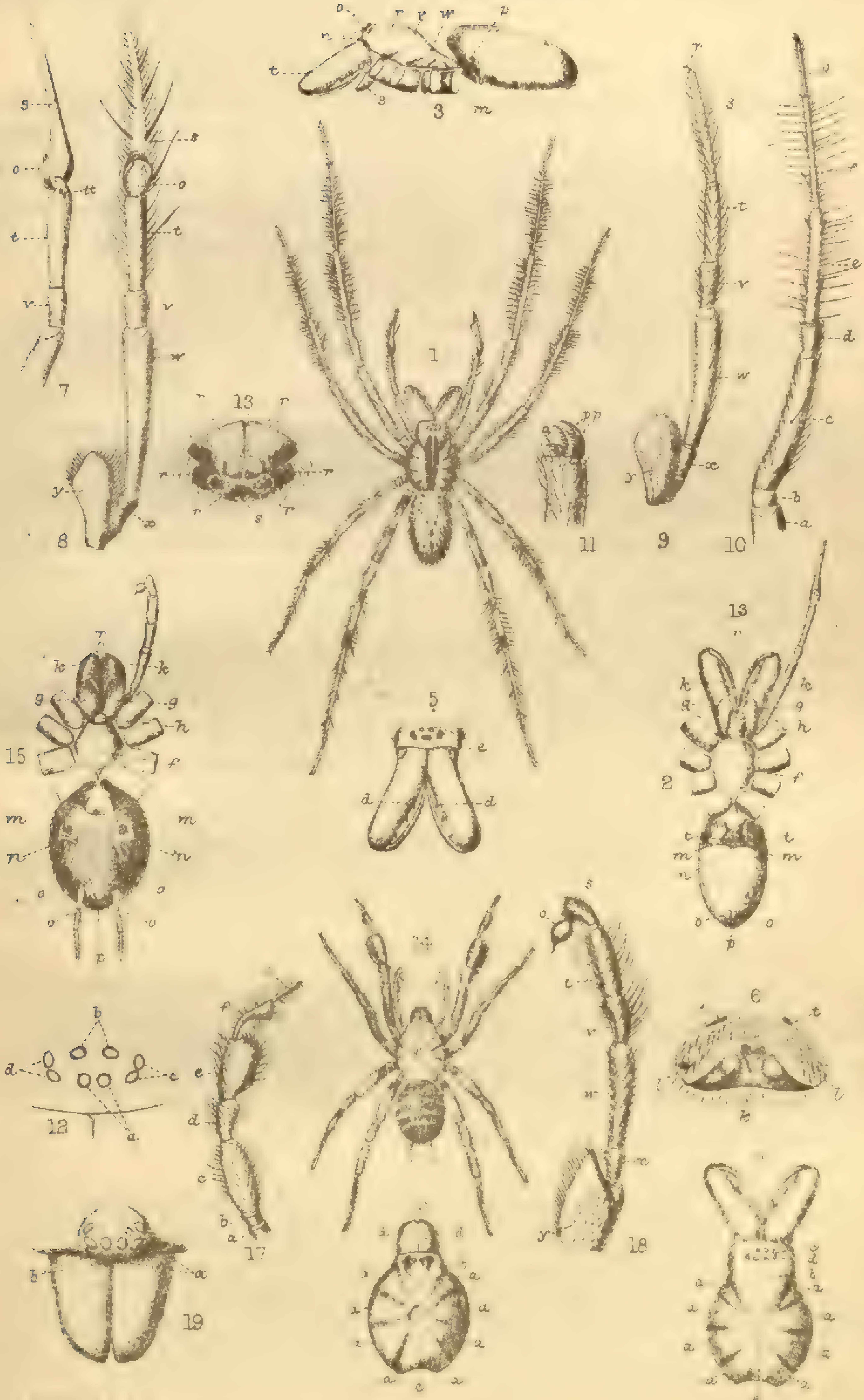
The *Eyes* are of tolerable size, but scarcely differing from each other in that

respect. They are in two curved rows, forming a transverse oval figure, about double as long as it is broad at its broadest diameter. The eyes of the hinder row are equi-distant from each other. The fore central eyes are rather nearer together than each is to the lateral of the same row on its side. Those of each lateral pair are seated slightly obliquely on a not very prominent tubercle, and are near to each other, but not contiguous.

The *Legs* are long and tolerably strong; their relative length is 1, 2, 4, 3, and they are furnished with spines (not very long nor strong), and with numerous—some nearly erect—hairs of different lengths. The colour of those of the two foremost pairs is yellow-brown, the femora and genuæ being darker than the rest, and with a very faint indication of a paler annulation both on the femora and tibiæ. The two hinder pairs are similarly coloured, but have two distinctly marked yellow annulations on each of the femoral and tibial joints; each tarsus terminates with three curved claws; the superior ones pectinated beneath the hinder half; the inferior one much the smallest, and strongly bent downwards near its base, where it has one or two teeth.

The *Palpi* are rather long and slender; they are of a reddish-yellow brown colour, the basal part of the radial joint being pale yellow brown, shading off into the redder part. The humeral joint is bent inwards; the radial is more than double the length of the cubital joint, and rather strongest at its fore extremity, near the outer side of which are two small apophyses; that nearest the base of the digital joint is the largest, of a flattened form and truncate extremity, the other (behind it) is sharp pointed, and of a somewhat tooth-like form. There is also a small prominent point beneath the larger apophysis above-mentioned. The digital joint is small, oval, but its extremity is greatly produced in a long cylindrical form, being a greatly exaggerated example of a somewhat similar form in *Argyroneta* and *Tegenaria.* The length of the digital joint considerably exceeds that of the radial and cubital together, being about equal to that of the humeral joint. The palpi, like the legs, are furnished with a few slender spines and long hairs; of the former are several longish conspicuous ones on the digital joints. The palpal organs are contained within the oval basal part of the digital joints; they consist of a simple whitish oval lobe, with a red-brown corneous lateral margin, probably an independent, though closely adhering, spine, but this I could not ascertain satisfactorily; there are also a sharp-pointed dark red-brown spine on their inner side, and a stronger obtuse corneous projection near their extremity, and a small one on the outer side.

The *Falces* are long, strong, divergent, and projecting forwards; their length is very nearly equal to that of the cephalo-thorax; the fangs are long and strong, and beneath them are several strong sharp teeth along the inner side of the falces, which are of a deep rich reddish chestnut brown colour, and



A.T. Hollick del.

furnished above with short strongish hairs; the fangs are of a still darker hue than the falces.

The *Maxillæ* are strong, straight, enlarged at their extremities, where they are rounded on the outer, and obliquely truncated on the inner-sides, the inner edges curved somewhat over the labium, which is of an oblong form, deeply notched or hollowed out in a circular form at its apex; these parts, as well as the sternum, which is of ordinary form, are of a dark red-brown colour, the labium being rather the darkest. The maxillæ are furnished with strong bristly hairs; those on the inside, and beneath their extremities, forming strong tufts. The labium and sternum are also furnished with hairs, and these are less strong than those on the maxillæ.

The *Abdomen* is of moderate size and oval form. Its fore part (looked at in profile) is high, and slopes gradually to the hinder extremity; the upper part and sides are of a dull yellowish colour, marked chiefly on the sides and outer edges of the upper part with black-brown spots and short striæ. There is also, on the fore part of the upper-side, an indication, by means of a dark, irregular margin, of a longitudinal central oblong marking, pointed at its hinder extremity, and with an obtusely angular prominence near the middle of each side—the hinder part of this marking is followed by other dark, irregular markings to the spinners. The under-side is suffused with dull brown, laterally bordered with a yellowish, ill-defined stripe, along which is a row of small, rust-red spots; there appears to be some variation in the markings on the upper side, one female being far more marked with black-brown, and having some oblique pale stripes on the sides. Besides the ordinary spiracular openings, there is, on either side, another narrow, reddish slit, or opening, a little above the usual one when the spider is looked at in profile (f. 3*p*). Also, between the large spiracular plates or opercula are two other still smaller openings of a reddish hue (f. 2*tt*), all of which probably open into spiracular tracheæ. These openings have been observed also in *Argyroneta*; and in the Drassoid genus *Anyphæna* analogous ones have been found between the ordinary spiracular plates. The spinners are very short; those of the inferior pair being the strongest, and of a paler hue than those of the superior pair.

The colours of the female are clearer, and the markings better defined than those of the male above described; their general character, however, is tolerably similar. The figure given (*l.c. supra*) by Dr. L. Koch, of the female, is excellent. I have not been able to learn anything of the habits or economy of this fine and remarkable spider.

Description of Plate VI.

CAMBRIDGEA FASCIATA (L. Koch), adult male.

Figs. 1—13.

Fig. 1—Spider of natural size.

2—Under-side with legs and palms truncated. *kk*, falces, with teeth along their inner edge; *rr*, fangs; *gg*, maxillæ; *h*, labium; *f*, sternum; *mm*, ordinary spiracular plates; *tt*, small folds, probably openings to supernumerary tracheæ; *n*, genital aperture; *o*, spinners; *p*, anal nipple.

3—In profile, with legs and palpi truncated. *n*, the clypeus; *o*, ocular area; *p*, supernumerary spiracular orifice; *m*, ordinary ditto; *r*, caput; *v*, occiput; *w*, thorax; *x*, falx.

4—Cephalo-thorax, from upper-side. *b*, caput; *a*, thoracic segments, the grooves indicating their junctional points, as shown by the converging lines; *e*, the indentation, showing the converging point; *c*, front row of eyes; *d*, hinder ditto.

5—Fore part of caput and falces from in front. *e*, facial space; *dd*, falces, showing teeth on their inner edges.

6—Fore part of abdomen of female underneath. *ll*, spiracular plates; *tt*, small folds, probably openings to tracheæ; *k*, genital aperture.

7—Portion of palpus, male; *o*, palpal organs; *tt*, apophyses at extremity of radial joint.

8—Palpus, male, with maxilla attached. *y*, maxilla; *x*, axillary joint; *w*, humeral joint; *v*, cubital joint; *t*, radial joint; *s*, digital joint; *o*, palpal organs.

9—Palpus, female. *r*, terminal palpal claw. The other joints as in fig. 8.

10—*Leg* of first pair. *a*, coxal joint; *b*, exinguinal joint; *c*, femoral; *d*, genual joint; *e*, tibial joint; *f*, metatarsus; *g*, tarsus.

11—Tarsus. *pp*, superior terminal tarsal claws; *o*, inferior ditto.

12—Fore part of caput to show the eyes. *a*, fore-central pair; *b*, hind-central pair; *c* and *d*, lateral pairs.

13—Hinder part of abdomen, beneath. *r*, spinners; *s*, anal orifice.

MACROTHELE HUTTONII, sp. n., adult male.

Figs. 14—19.

Fig. 14—Spider of natural size.

15—Under-side with legs and palpus truncated.

The different parts lettered are the same as those in figure 2, except *nn*, the additional pair of spiracular plates. Observe that the spinners here, *oo*, are only *four* in number.

16—Cephalo-thorax, from above.

The different parts lettered are the same as the corresponding ones in fig. 4. Observe the great development of the central junctional thoracic indentation, *c*.

17—Leg of first pair.

The different parts as in fig. 10. Observe the abnormal development of the tibial joint, *e*; as also the unusual conformation of the metatarsus, *f*.

18—Palpus of male.

The different parts as in fig. 8. Observe the different type of maxillæ; *y*, the palpus springing from near its extremity; as also the different type of palpal organs, *o*, and the much smaller development of the digital joint, *s*.

19—Fore right view of eyes. *a*, facial space; *b*, clypeus.

III.—BOTANY.

ART. XXXVII.—*List of the* Algæ *of the Chatham Islands, collected by H. H. Travers, Esq., and examined by Professor John Agardh, of Lund.* Communicated by Baron FERD. VON MUELLER, C.M.G., M.D., F.R.S., Hon.Mem.N.Z.I.

[*Read before the Wellington Philosophical Society, 1st September,* 1873.]

EARLY last year I was entrusted by Mr. H. H. Travers with a collection of Algæ, obtained by him with a large number of other plants during his second visit to the Chatham Islands. I was glad to induce my friend Professor Dr. Agardh, of Lund, to undertake the laborious task of the examination of these Algæ, as here, not only the Museum material for comparison of this kind of plants, but also the extent of our libraries for phycologic studies, are quite inadequate; and besides the systematic determination requires great circumspectness, many Algæ being of wide and much interrupted oceanic distribution. Moreover, no one could have brought to bear on this investigation the unrivalled experience of the great phycologist of Lund, gained after life-long special researches, which came to him as an inheritance from an illustrious parent. Dr. Agardh had already, at my request, examined the few Algæ brought by Mr. Travers from the Chatham Islands in 1864. The latter gentleman, encouraged by the well-proved discovery of a few new species on that occasion, effected last year a far more extensive search. The result has been that he brought together 46 genera and 62 species of these kinds of oceanic plants; and it is further gratifying to observe that he thereby added now again 2 genera and 10 species to the New Zealand flora, and indeed to science. Of the whole series a list is appended, arranged in accordance with the sequence adopted in Dr. Hooker's handbook. Diagnoses of the new generic and specific forms will soon be published in Sweden by Dr. Agardh.

It is, however, not likely that Mr. Travers' creditable exertions have already rendered known all the sea plants of this order occurring on the shores of the Chatham group; on the contrary, it may be expected that settlers on the various islands, able to watch what the gales may cast ashore at various seasons, or equally able to effect dredging at various places, will still largely add to the number of the Algæ now recorded from thence. It is also to be hoped that the enthusiastic young naturalist, to whom we mainly owe our knowledge of the vegetation of the Chatham Islands, will soon gain a new and fruitful field for a continuation of his important exertions.

LIST OF ALGÆ.

Sargassum
plumosum, Ach. Rich.
——— a species allied to *S. sinclairii*, J. H. and Harv.
Carpophyllum
phyllanthum, J. H. and Harv.
maschalocarpum, J. H. and Harv.
Marginaria
urvilleana, Ach. Rich.
Cystophora
scalaris, J. Ag.
distenta, J. Ag.

This, by a writing or printing error, was called *C. dissecta* in Trans. N.Z. Inst., Vol. III., p. 214.

Landsburgia
quercifolia, J. H. and Harv.
myricifolia, J. Ag.
Fucodium
gladiatum, J. Ag.
Carpomitra
halyseris, J. H. and Harv.
Ecklonia
radiata, J. Ag.
Zonaria
turneriana, J. Ag.
Dictyota
kunthii, Ag.
Adenocystis
lessonii, J. H. and Harv.
Sphacelaria
paniculata, Suhr.
Rhodomela
traversii, J. Ag., n. sp.
Polysiphonia
lyallii, J. H. and Harv.
muelleriana, J. Ag.
ramulosa, Harv.

Or a species closely allied to it.

Polyzonia
incisa, J. Ag.

On *Pterocladia lucida.*

Champia
novæ-zealandiæ, Harv.
Laurencia
urceolata, J. Ag., n. sp.
thyrsifera, J. Ag., n. sp.
Dactylotus
oblongifolius, J. Ag.

(*Cladhymenia oblongifolia*, Harv.)

Amphiroa
corymbosa, Harv.

The identity with Decaisne's South African plant doubtful.

wardii, J. Ag.
Jania
cuvierii, Decaisne.
Nitophyllum
palmatum, Harv.
Gracilaria
flagelliformis, J. Ag., n. sp.
Caulacanthus
spinellus, Kuetz.
Pterocladia
lucida, J. Ag.
Apophlœa
lyallii, J. H. and Harv.
Wrangelia
lyallii, Harv.
Rhodymenia
corallina, Grev.
Hymenocladia
lanceolata, J. Ag.
Rhodophyllis
acanthocarpa, J. Ag.

(*Callophyllis acanthocarpa*, Harv.)

Plocamium
coccineum, Lyngb.
Gymnogongrus, sp.

The collected specimens are sterile.

Callophyllis
hombroniana, Kuetz.
Gigartina
angulata, J. Ag., n. sp.
marginifera, J. Ag.
decipiens, J. H. and Harv.
radula, J. Ag.
Epymenia
obtusa, Harv.

Perhaps distinct from the South African plant.

Chrysymenia
linearis, J. Ag.
Grateloupia
caudata, J. Ag., n. sp.
Ceramium
nodiferum, J. Ag., n. sp.
stichidiosum, J. Ag., n. sp.
Centroceras
clavulatum, Montagn.

Ptilota
formosissima, Mont.
Pandorea
traversii, J. Ag., n. g.
Griffithsia
sonderiana, J. Ag., n. sp.
antarctica, J. H. and Harv.
gracilis, Harv.
Or an allied species in a sterile state.
Ballia
brunonis, Harv.
scoparia, Harv.
Caulerpa
furcifolia, J. H. and Harv.
Codium
tomentosum, Ag.
adhærens, Ag.
Bryopsis
prolifica, J. Ag.
Ulva
rigida, Ag.

Art. XXXVIII.—*Notes on the Flora of the Province of Wellington, with a List of Plants collected therein.* By John Buchanan, of the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 16th January,* 1874.]

The following list of plants has been determined from specimens chiefly collected in the southern portion of the Province of Wellington. The district now under notice may be defined as south of a line drawn between the Wanganui River on the west and Castle Point on the east. The surface features of this area will be found to present two main lines of watershed with a north and south axis, the altitudes ranging up to 5,000 feet. The relative area of bush and open land are, according to Mr. J. T. Stewart, nearly equal,* the bush being more confined to the western range, while the great central river basin and hills of the eastern range are comparatively open land, and covered by a vegetation of fern, grass, and low-growing plants, little having as yet been done to improve upon the primitive condition of the country, except partial clearing by fire.

The river basins of this district are well adapted for agriculture; the inorganic matter from the wear of rocks, brought down by the streams from mountain ranges of a varied geology, with the added organic matter of a luxuriant natural vegetation—the accumulation of ages—present all the elements of a fertile soil. The extension of pasture is the main object at present in clearing land, but where bush is cleared for this purpose the rough and slovenly method usually adopted does not produce a first-class pasture, although bush soil is capable of growing excellent crops of either roots or cereals.

On the extensive hill lands of the eastern division of the district, however,

* Trans. N.Z. Inst., Vol. II., Art. XLVIII., "On the River System of the South Portion of the Province of Wellington," by J. T. Stewart.

where the tertiary limestones prevail, and where there is comparatively little bush, sufficient has been done by a few enterprising settlers to show that this open land is capable of carrying a pasture equal to any in New Zealand, and must, when improved extensively, become a source of great wealth in the future.

Soils vary according to the character of the rock formations from which they are derived, and, by thus supplying in certain cases adaptative food to certain species of plants, influence their geographical distribution ; on some such theory only can we account for the presence of particular species within certain areas, and the apparent inadaptative nature of those areas for other species. So strong is this influence in some cases that soil appears to dominate over temperature. The selected habitats of the *Fagus* species in Wellington is a notable instance of this, and so well marked is it in the Upper Wairarapa valley, that if we view the Tararua mountains from a distance of five to seven miles from the east, we may be able to determine the geological formation of the range by its botanical facies.

The rugged outline of the alpine region is clearly shown against the sky at a varying altitude of 3,000 to 5,000 feet. The vegetation consists of grass with low-growing plants, the result of a low temperature and fierce cold winds. The soil here is derived from palæozoic rocks, but sufficient observations have not been made to show the relation between varieties of soil in this region and the distribution of species, temperature ruling supreme as regards size.

The middle altitudes of the range show, in the uniform dull-green colour and even surface, the unmistakable presence of *Fagus* bush, one species creeping up the gullies till it becomes gnarled and stunted in growth. In this middle region the rocks are triassic, and reach to a considerable altitude. The same formation on Wellington harbour hills carries the same species of *Fagus* from the level of the sea. No doubt the species of this genus have an extensive range, both laterally and altitudinally, for in the South Island they reach altitudes of at least 4,000 feet ; but within this natural range of temperature they show a decided preference for soils derived from mesozoic rocks.

The vegetation of the lower altitudes of the Tararuas is chiefly composed of that mixed bush so characteristic of New Zealand scenery, numerous specimens of *Fagus* being also scattered amongst it. This region is the habitat of the pines and numerous other genera of varied foliage, the whole, when brightened by the showy flowers of such species as *Metrosideros robusta* or *Weinmannia racemosa*, forming a very pleasing picture. This mixed bush has several lateral extensions on the river flats, and indicates on the hills the area of the tertiary rocks.

The climate of Wellington, as regards temperature, is mild and equable.

The influence of temperature, however, in producing a luxuriant plant-growth is of less importance than humidity, whether derived from the normal humid condition of the prevailing winds, or locally by the evaporation from swamp lands or the cover of bush. The amount of humidity present in the atmosphere differs much in different districts, and can be easily known without the aid of meteorological instruments by the greater or less abundance of those low forms of vegetable life—the lichen-fungi—whose minute forms often give a colouring to rocks and bark of trees. They are seldom found where dry winds prevail, but often in great profusion on the coast line, and inland for several miles, and at altitudes on the hills where rain-clouds hang. The normal condition of the sea-winds at Wellington is humid, but for short periods cold arid winds accompanied by rain prevail, whose blighting influence on some plants, especially those with membranaceous leaves, or tender introduced species, is almost destructive, and, but for the shelter of more robust species, many (such as *Piper excelsum*) would become extinct. This blighting influence of the sea-winds has been erroneously ascribed to the presence of salt carried from the ocean; but if this were the case every storm should produce the same blighting effect, whereas it occurs seldom more than once or twice in a year, and only for a few hours.

For convenience the flora of Wellington will be arranged under five natural divisions: bush, open land, alpine, littoral, and marine. From the equability of the climate, the species of the first and second divisions are very uniformly distributed over their own areas up to 2,000 feet. It is presumed, therefore, that any artificial system of zones of altitudinal distribution in a district where the greatest altitudes are only 5,000 feet would fail in correctness, as it has been already shown that the selection of habitat by species within this limit is more influenced by soil than temperature.

The geographical position of the timber trees is a subject of much importance in a commercial point of view. As the country is opened up by railroads it will be found that the species easiest reached differ in different districts, both in kind and value. The value of any timber being proportionate to its strength and durability for constructive or other works, these qualities again are entirely ruled by the kind of soil and the amount of exposure under which it is grown. For it is an erroneous idea that if once some particular kind of tree, such as totara, has produced durable timber, all totara will be durable; for that which is grown on rich alluvial sheltered bottoms will, undoubtedly, be inferior in durability to that which is grown on exposed hill-ridges, the growth of the latter being much slower, producing a timber of greater specific gravity and containing more secreted oil. So, also, does soil and exposure influence the strength of those timbers which are selected for building purposes (such as rimu), where capacity to resist transverse strain is

required. In experiments made on the strength of timbers for the New Zealand Exhibition Commissioners, it was clearly proved that in certain localities the timber of rimu was much stronger than in others, and the only reason that can be assigned for this is the difference in soil and exposure.

But little need be said on the vegetation of the open land, which, in almost every locality, is either grass or fern, with intervals of scrub. A list of the plants of this division has already been given in a paper on the flora of the Miramar Peninsula (Trans. N.Z. Inst., Vol. V., p. 349).

The indigenous grasses are sparsely spread, but improve by grazing if not too often burned. They generally disappear before British grasses, not from possessing a lesser vitality, but from being unduly handicapped in the struggle. There is probably no instance of the native grass-seeds being collected and sown, while this is frequently done with the British species, some of which would, no doubt, disappear also but for being re-sown.

The alpine region in Wellington is but little known. Those plants collected prove to be chiefly South Island species, with a few Ruahine Mountain species, the latter having been first collected there by Mr. Colenso. Many new species may still be expected to be found in this region when more thoroughly examined.

The littoral region differs little over the entire coast of New Zealand, thus proving a great uniformity in the conditions of plant-life there. A list of the species peculiar to this division will be found in Trans. N.Z. Inst., Vol. V., p. 349.

In the marine region the Algæ of the southern coast of Wellington are peculiarly rich in the Melanospermæ, or large-sized species of the order, masses of them having, no doubt, been drifted by the currents and storms of the south from other islands, although the same species are also indigenous to New Zealand. In proof of this, and as fixing the locality whence some may have come, *Ostrea virginica*, a mollusc of the Chatham Islands, has been found attached to one of these floating masses; again, *Acanthocœtes ovatus*, a rare mollusc founded by Captain Hutton on a single specimen (of unknown locality), has since been found deeply imbedded in a large floated stem of *Macrocystus pyrifera*, from which it may be inferred that both plant and mollusc are immigrants to New Zealand.

The storm-beaten shores of Wellington, with limited shelter, are but little adapted to the growth of the more delicate Rhodospermæ, hence the fewness of those found, except when parasitic on the larger species.

The other orders of the Cryptogamia have their habitats spread over all the regions of the Phanerogamia. The alpine forms are little known, and the whole, especially Fungi, still offer a rich field for further research in Wellington.

In Musci and Hepaticæ the list now offered may still be incomplete, as it is compiled only from the collection of the writer, in whose hands they have all undergone a recent microscopical examination, and, although some errors may occur in his determination of the species of this interesting though difficult order, the list must still include all the most prominent forms which are likely to be found in the district under notice.

In Lichenes I am indebted to Dr. Stirton, of Glasgow, for the greater part of the determinations, and among several sent to him he has been fortunate in discovering many new species, as also a few species new to New Zealand, but known previously to science. He has also kindly sent descriptions of the new species which will be found appended to this paper, and which will no doubt prove useful to local botanists.

The Fungi I had intended to have left entirely out, but having drawings of some easily recognized species, they have, with a few others, been added.

The additions to the flora of Wellington, which have been placed in the Colonial Herbarium by others than the writer during the last five years, are a collection of flowering plants from the neighbourhood of the City of Wellington by Mr. Holmes. The more rare additions are a collection made by Dr. Hector from the Upper Rangitikei District and the East Coast, where he determined the most northern locality for *Celmisia coriacea*, and the most southern for *Pomaderris phylicifolia*; a collection of alpine plants, made by Mr. Mitchell, of the Provincial Survey Department, whose zeal in the cause of science is worthy of imitation by others having similar opportunities; and a collection of a few rare plants of northern type from the West Coast, made by Mr. Hamilton, including *Rhabdothamnus solandri*, *Pomaderris phylicifolia*, and *Sparganium simplex*.

The number of species in my list as compared with the whole flora of New Zealand is as follows:—

	Wellington.	New Zealand.
Phanerogamia	486	980
Filices	105	134
Musci	160	343
Hepaticæ	86	232
Lichenes	151	212
Fungi	52	219
Algæ	100	319
	1,140	2,439

DICOTYLEDONS.

RANUNCULACEÆ.

Clematis indivisa, Willd. Fl. Aug.—Nov.; white.
hexasepala, DC. Fl. Oct., Nov.; white.
parviflora, A. Cunn. Fl. Oct., Nov.; greenish yellow.
colensoi, Hook. f. Fl. Oct.—Dec.; greenish white, sweet scented.
Myosurus aristatus, Benth. Ocean Beach, Island Bay.
Ranunculus insignis, Hook. f. Tararua Mountains. Fl. yellow.
nivicola, Hook. Upper Rangitikei. Fl. Feb.; yellow.
plebeius, Br. Fl. Oct.—July; yellow.
lappaceus, Sm., var. *multiscapus*. Fl. Nov.—March; yellow.
macropus, Hook. f. Fl. Dec., Jan.; Wainuiomata; yellow.
rivularis, Banks and Sol., vars. *a.* and *b.* Fl. Nov.—March; yellow.
acaulis, Banks and Sol. Ocean Beach. Fl. Nov.—Jan.; yellow.
parviflorus, Linn., var. *australis*. Fl. Nov., Dec.; yellow.

MAGNOLIACEÆ.

Drimys axillaris, Forst. Fl. Aug.—Dec.; fl. white, berries red.
colorata, Raoul. Fl. Sept.—Dec.; fl. white, berries black.

CRUCIFERÆ.

Nasturtium palustre, DC. Upper Wairarapa. Fl. Nov., Dec.; yellow.
Barbarea vulgaris, Linn. Fl. Sept.—Feb.; yellow.
Cardamine hirsuta, Linn., vars. *a.* and *b.* Fl. through the year; white.
Lepidium oleraceum, Forst. Ocean Beach. Fl. Nov., Dec.; white.

VIOLARIEÆ.

Viola filicaulis, Hook. f. Fl. Dec.—Feb.; white.
cunninghamii, Hook. f. Fl. Dec., Jan.; white.
Melicytus ramiflorus, Forst. Fl. Oct.—April; greenish yellow, sweet scented.
lanceolatus, Hook. f. Wainuiomata. Fl. Dec.—Feb.
micranthus, Hook. f. Upper Wairarapa.
Hymenanthera crassifolia, Hook. f. Fl. July, Aug.; pale yellow.
latifolia, Endl. A plant from the Upper Rangitikei, in fruit, with coriaceous leaves three to four inches long, serrated, and acuminate at both ends, may be this.

PITTOSPOREÆ.

Pittosporum tenuifolium, Banks and Sol. Fl. Oct.—Dec.; dark purple.
colensoi, Hook f, Upper Rangitikei. Fl. Oct.—Dec.; dark purple.
buchanani, Hook. f. Wanganui. Fl. Oct.—Jan.; dark purple.
eugenioides, A. Cunn. Fl. Oct., Nov.; pale yellow, sweet scented.
cornifolium, A. Cunn. Fl. Sep., Oct.; dark purple.

CARYOPHYLLEÆ.

Stellaria parviflora, Banks and Sol. Fl. Dec., Jan.; white.
elatinoides, Hook. f. Fl. Dec., Jan.; white.
gracilenta, Hook. f. Fl. Dec., Jan.; white.
Colobanthus billardieri, Fenzl. Fl. Aug.—Dec.
subulatus, Hook. f.
acicularis, Hook. f.
Spergularia rubra, Pers., var. *marina*. Fl. Aug.—Dec.; pink.

Portulaceæ.

Montia fontana, Linn. Fl. Dec.; white.

Elatineæ.

Elatine americana, Arnot. Island Bay.

Hypericineæ.

Hypericum gramineum, Forst. Fl. Dec.—March; yellow.
japonicum, Thunb. Upper Rangitikei.

Malvaceæ.

Plagianthus divaricatus, Forst. Evans Bay. Fl. Aug.—Nov.
betulinus, A. Cunn. Fl. Oct., Nov.; white.
Hoheria populnea, A. Cunn.
var. *b. lanceolata*. Fl. Dec., Jan.; white.
var. *c. angustifolia*. Upper Wairarapa. Fl. Jan., Feb.; white.

Tilliaceæ.

Aristotelia racemosa, Hook. f. Fl. July—Nov.; pink.
erecta, n.s. Upper Rangitikei. Fl. Dec., Jan.; pink.
fruticosa. Upper Rangitikei. Fl. Dec., Jan.; pink.
Elæocarpus dentatus, Vahl. Fl. Nov., Dec.; white.
hookerianus, Raoul. Wainuiomata. Fl. Nov., Dec.; white.

Lineæ.

Linum monogynum, Forst. Fl. through the year; white.
marginale, A. Cunn. Upper Rangitikei. Fl. Dec.; white.

Geraniaceæ.

Geranium dissectum, Linn., var. *carolinianum*. Fl. Dec.—March.
microphyllum, Hook. f. Fl. Dec.
sessiliflorum, Cav. Fl. Nov., Dec.; pink.
molle, Linn. Fl. Nov.—Feb.; white or pinkish.
Pelargonium australe, Willd., var. *clandestinum*. Fl. Dec., Jan.; pink.
Oxalis corniculata, Linn. The vars. of this sp. fl. during summer—yellow.
magellanica, Forst. Fl. Nov., Dec.; white.

Rutaceæ.

Melicope ternata, Forst. Fl. Aug.—Nov.; pale greenish yellow.
mantellii, n. s. Fl. Aug.—Nov.; pale greenish yellow.
simplex, A. Cunn. Fl. Oct., Nov.; pale greenish white.

Meliaceæ.

Dysoxylum spectabile, Hook. f. Fl. April—Sep.; white.

Olacineæ.

Pennantia corymbosa, Forst. Fl. Nov., Dec.; white.

Rhamneæ.

Pomaderris phylicifolia, Lodd. Otaki, Upper Wairarapa. Fl. Dec., Jan.
Discari toumatou, Raoul. Fl. Oct.—Jan.; white.

Sapindaceæ.

Dodonæa viscosa, Forst. Fl. Nov., Dec.; white.
Alectryon excelsum, DC. Fl. Nov., Dec.; greenish white.

ANACARDIACEÆ.

Corynocarpus laevigata, Forst. Fl. Sep.—Nov.; white.

CORIAREÆ.

Coriaria ruscifolia, Linn. Fl. Oct.—Dec.
thymifolia, Humb. Upper Rangitikei.

LEGUMINOSEÆ.

Carmichellia australis, Br. Fl. Dec., Jan.
odorata, Col. Upper Wairarapa. Fl. white purple.
flagelliformis, Col. Patea plains.
Sophora tetraptera, Aiton.
var. *a. grandiflora*. Fl. Oct., Nov.; yellow.
var. *b. microphylla*. Upper Wairarapa. Fl. Oct., Nov.; yellow.

ROSACEÆ.

Rubus australis, Forst.
var. *a. glaber*. Fl. Oct.; white.
var. *b. schmidelioides*. Fl. Oct., Nov.; white.
var. *c. cissoides*. Fl. Oct., Nov.; white.
Potentilla anserina, Linn. Fl. Dec.—Feb.; yellow.
Geum urbanum, Linn., var. *strictum*. Upper Wairarapa. Fl. Dec.; yellow.
Acæna sanguisorbæ, Vahl. Fl. during summer.

SAXIFRAGEÆ.

Carpodetus serratus, Forst. Fl. Dec.; white.
Weinmannia racemosa, Forst. Fl. Nov., Dec.; pinkish white.

TILLÆA.

Tillæa verticillaris, DC. Fl. Oct.—Dec.
purpurata, Hook. f. Sinclair Head.

DROSERACEÆ.

Drosera binata, Labill. Fl. Nov., Dec.; pinkish white.
auriculata, Back. Fl. Oct.—Dec.; pinkish white.

HALORAGEÆ.

Haloragis alata, Jacq. Common near Wellington.
tetragyna, Labill. Wairarapa.
depressa, Hook. f.
Myriophyllum elatinoides, Gaud. Fl. Nov., Dec.
pedunculatum, Hook. f. Evans Bay.
Gunnera prorepens, Hook. f. Upper Wairarapa.

MYRTACEÆ.

Leptospermum scoparium, Forst. Fl. through the year; white.
ericoides, A. Rich. Fl. Dec., Jan.; white.
Metrosideros florida, Sm. Fl. through the year; red.
lucida, Menz. Fl. Nov.—Jan.; red.
diffusa, Smith. Tararua Mountains. Fl. Oct., Nov.; red.
hypericifolia, A. Cunn. Fl. Dec., Jan.; white.
colensoi, Hook. f. Fl. Dec., Jan.; white.
robusta, A. Cunn. Fl. Nov.—Jan.; red.
scandens, Banks and Sol. Fl. Feb., March; white.

Myrtus bullata, Banks and Sol. Fl. Jan., Feb. ; white.
ralphii, Hook. f. Fl. Dec., Jan. ; white.
obcordata, Hook. f. Fl. Nov.—Jan. ; white.
pedunculata, Hook. f. Fl. Dec., Jan. ; white.
Eugenia maire, A. Cunn. Fl. June, July ; white.

ONAGRARIEÆ.

Fuchsia excorticata, Linn. f. Fl. Sep.—Jan. ; red.
colensoi, R. Cunn. Fl. Nov.—Jan. ; red.
Epilobium nummularifolium, A. Cunn. Fl. Sep.—March.
linnæoides, Hook. f. Fl. Sep.—Dec.
macropus, Hook. Fl. Nov.—Jan. Wainuiomata.
confertifolium, Hook. f., var. *a*. Fl. Dec., Jan.
alsinoides, A. Cunn. Fl. Nov., Dec.
rotundifolium, Forst. Fl. Nov.—March ; white.
glabellum, Forst. Fl. Nov.—Feb. Wainuiomata.
melanocaulon, Linn. Fl. Dec.
tetragonum, Linn. Fl. Dec., Jan.
pubens, A. Rich. Fl. Oct.—Jan.
billardierianum, Seringe. Fl. Nov.—Jan. ; pinkish.
pallidiflorum, Sol. Fl. Nov.—Feb. ; pinkish.

PASSIFLOREÆ.

Passiflora tetrandra, Banks and Sol. Fl. Dec., Jan. ; white or yellow, with sometimes coloured markings.

FICOIDEÆ.

Mesembryanthemum australe, Sol. Fl. Aug.—Feb. ; pinkish.
Tetragonia expansa, Murray. Fl. Dec.—Feb. ; yellow.

UMBELLIFERÆ.

Hydrocotyle elongata, A. Cunn. Fl. Jan., Feb.
americana, Linn. Fl. Dec.—Feb.
asiatica, Linn. Fl. Dec.—March.
novæ zealandiæ, DC. Fl. Dec.—Feb.
moschata, Forst. Fl. Jan.—March.
Crantzia lineata, Nutt. Lyall Bay. Fl. Jan., Feb.
Apium australe, Thouars. Fl. Aug.—March.
filiforme, Hook. Fl. Sept.— March.
Eryngium vesiculosum, Labill. Sinclair Head.
Aciphylla squarrosa, Forst. Wellington Harbour. Fl. Dec., Jan.
colensoi, Hook. f. Tararua Mountains.
Ligusticum lyallii, Hook. f. Tararua Mountains.
aromaticum, Banks and Sol. Patea Plains.
Angelica gingidium, Hook. f. Upper Wairarapa. Fl. Nov.—Jan.
rosæfolia, Hook. Upper Rangitikei. Fl. Jan. ; white.
geniculata, Hook. f. Kaiwarra. Fl. Nov., Dec.
Daucus brachiatus, Sieber. Upper Wairarapa.

ARALIACEÆ.

Panax simplex, Forst. Fl. Sep.—Nov.
edgerleyi, Hook. f. Fl. Nov., Dec.
anomalum, Hook.
crassifolium, Dcne. and Planche.
arboreum, Forst. Fl. Aug.—March.

Schefflera digitata, Forst. Fl. Jan., Feb.

CORNEÆ.

Griselinia lucida, Forst. Fl. Oct.—Dec.; greenish white.
littoralis, Raoul. Fl. Oct.—Dec.; greenish white.
Corokia cotoneaster, Raoul. Upper Wairarapa. Fl. Nov., Dec.; yellow.

LORANTHACEÆ.

Loranthus colensoi, Hook. On *Pittosporum tenuifolium.*
flavidus, Hook. f. On *Fagus.*
micranthus, Hook. f. Common on various plants.
Tupeia antarctica, Cham. and Schl. Fl. Aug.
Viscum salicornioides, A. Cunn. Common on manuka.

CAPRIFOLIACEÆ.

Alseuosmia macrophylla, A. Cunn. Fl. Dec.; greenish white, sweet scented.

RUBIACEÆ.

Coprosma lucida, Forst. Fl. July—Nov.
grandifolia, Hook f. Fl. July—Oct.
baueriana, Endl. Fl. July—Dec.
petiolata, Hook. f. Fl. Dec.
robusta, Raoul. Fl. July—Dec.
cunninghamii, Hook. f. Fl. Aug.—Oct. Hutt.
rotundifolia, A. Cunn. Nov.
tenuicaulis, Hook. f. Fl. Sep.—Oct.
rhamnoides, A. Cunn. Fl. Sep., Oct.
divaricata, A. Cunn. Fl. Aug.—Oct.
parviflora, Hook. f. Fl. Aug., Sep.
propinqua, A. Cunn. Fl. Sep., Oct.
fœtidissima, Forst. Fl. Oct., Nov.
acerosa, A. Cunn. Fl. July, Aug.
depressa, Col. In fruit Nov.
microcarpa, Hook. f. In fruit Nov.
Nertera dichondræfolia, Hook. f. Fl. Nov., Dec.
setulosa, Hook. f. Wainuiomata. Fl. Dec.
Galium tenuicaule, A. Cunn. Fl. Nov., Dec.
umbrosum, Forst. Fl. Nov., Dec.
Asperula perpusilla, Hook. f. Fl. Dec.

COMPOSITÆ.

Olearia colensoi, Hook. f. Tararua Mountains.
nitida, Hook. f. Fl. Oct.—June; white.
ilicifolia, Hook. f. Tararua Mountains. Fl. Dec., Jan.; white.
cunninghamii, Hook. f. Fl. Oct.—Dec.; white.
lacunosa, Hook. f. Tararua Mountains. Fl. Dec., Jan.; white.
excorticata, sp. nov. Tararua Mountains. Fl. Dec., Jan.
nummularifolia, Hook. f. Upper Rangitikei. White.
forsteri, Hook. f. Fl. March, April; white.
virgata, Hook. f., var. *a.* Upper Wairarapa. Fl. Nov., Dec.; white.
solandri, Hook. f. Fl. Nov.—July; white.
Celmisia densiflora, Hook. f. Tararua Mountains. White and yellow.
coriacea, Hook. f. East Coast. White and yellow.
spectabilis, Hook. f. East Coast. White and yellow.

Celmisia (continued)
longifolia, Cass. East Coast. White and yellow.
hectori, Hook. f. Tararua Mountains.
glandulosa, Hook. f. Upper Rangitikei. White and yellow.
Vittadinia australis, A. Rich. Fl. Dec.—March; white.
Lagenophora forsteri, DC. Fl. Nov.—April; white.
petiolata, Hook. f. Fl. Dec.; white.
Brachycome sinclairii, Hook. f. Nov.—Feb.; white.
odorata, Hook. f. Wanganui. Fl. Dec., Jan.; white.
Cotula coronopifolia, Linn. Fl. through the year; yellow.
australis, Hook. f. Fl. through the summer; pale yellow.
minor, Hook. f. Fl. through the summer; pale yellow.
perpusilla, Hook. f. Fl. Dec.—March; pale yellow.
divica, Hook. f. Fl. Dec.—Feb.; pale yellow.
minuta, Forst. Fl. Dec., April; pale yellow.
Craspedia fimbriata, DC. Fl. Jan.—March; pale yellow.
alpina, Back. Fl. Jan.—March; pale yellow.
Cassinia leptophylla, Br. Fl. Oct.—April; white.
fulvida, Hook. f. Fl. Jan.—March; white.
Ozothamnus glomeratus, Hook. f. Fl. Nov.—March; white.
Raoulia australis, Hook. f. Fl. Nov., Dec.; white.
tenuicaulis, Hook. f. Fl. Nov., Dec.; white.
grandiflora, Hook. f. Fl. Nov.—Jan.; white.
mammillaris, Hook. f. Tararua Mountains. White.
Gnaphalium prostratum, Hook. f. Fl. Nov.—Feb.; white.
bellidioides, Hook. f. Fl. Nov.—Feb.; white.
keriense, A. Cunn. Upper Wairarapa. Fl. Nov., Dec.; white.
var. *b. linifolia*, Wanganui. Fl. Nov., Dec.; white.
filicaule, Hook. f. Fl. Nov.—Feb.; white.
luteo-album, Linn. Fl. Nov.—March; pale yellow.
involucratum, Forst. Fl. Nov.—March; pale yellow.
collinum, Labill. Fl. Dec.; pale yellow.
Erechtites prenanthoides, DC. Fl. Nov., Dec.
arguta, DC. Fl. Nov., Dec.
scaberula, Hook. f. Upper Rangitikei.
quadridentata, DC. Fl. Nov.—Feb.
Senecio lagopus, Raoul. Fl. Dec., Jan.; yellow.
latifolius, Banks and Sol. Fl. Jan., Feb.; yellow.
lautus, Forst. Fl. through the year; yellow.
glastifolius, Hook. f. Sub-alpine. Fl. Oct.—Dec.; white and yellow.
elæagnifolius, Hook. f. Sub-alpine. Fl. Jan.—March; yellow.
bidwillii, Hook. f. Tararua Mountains, 5,000 feet.
Brachyglottis repanda, Forst. Fl. Oct., Nov.; white.
Microseris forsteri, Hook. f. Fl. Dec., Jan.; yellow.
Sonchus oleraceus, Linn. Fl. Dec.—June; yellow.

Stylidieæ.

Helophyllum colensoi, Hook. f. Tararua Mountains. Fl. Feb.; white.

Campanulaceæ.

Wahlenbergia gracilis, A. Rich. Fl. Nov.—March; blue.
saxicola, A. DC. Sub-alpine. Fl. Jan.; blue.
cartilaginea, Hook. f. Upper Rangitikei.

Lobelia anceps, Thunb. Fl. Nov.—May ; blue.
Pratia angulata, Hook. f. Fl. Dec.—Feb. ; pale blue.
macrodon, Hook. f. Fl. Jan. ; pale blue.
Sellieria radicans, Cav. Fl. Nov., Dec. ; white.

Ericeæ.

Gaultheria antipoda, Forst.
var. *a.* Wairarapa. Fl. Nov.—Jan. ; white.
var. *b.* Upper Rangitikei. Fl. Dec., Jan. ; white.
var. *c.* Upper Rangitikei. Fl. Dec., Jan. ; white.
rupestris, Br.
var. *a.* Tararua Mountains. Fl. Dec., Jan. ; white.
var. *c.* Lowry Bay. Fl. Dec., Jan. ; white.
Cyathodes acerosa, Br. Fl. Aug.—Dec. ; white.
empetrifolia, Hook. f. Patea District.
Leucopogon fasciculatus, A. Rich. Fl. Aug.—Dec. ; white.
frazeri, A. Cunn. Fl. Sep.—Jan. ; white.
Dracophyllum recurvum, Hook. f. Patea District.
urvilleanum, A. Rich. Fl. Jan., Feb. ; white.
rosmarinifolium, Forst. Tararua Mountains. Fl. white.

Myrsineæ.

Myrsine salicina, Heward. Fl. Oct., Nov.
urvillei, A. DC. Fl. April, May.
divaricata, A. Cunn.
nummularia, Hook. f. Upper Rangitikei.

Primulaceæ.

Samolus littoralis, Br. Fl. Dec.—March ; white.

Jasmineæ.

Olea cunninghamii, Hook. f.

Apocyneæ.

Parsonsia albiflora, Raoul. Fl. Oct.—May ; white.
rosea, Raoul. Fl. Nov.—March ; white.

Loganiaceæ.

Geniostoma ligustrifolium, A. Cunn. Fl. Oct.—Dec. ; greenish white.

Gentianeæ.

Gentiana montana, Forst. Fl. March, April. Tararua Mountains.
pleurogynoides, Grisel. Fl. March, April. Tararua Mountains.
saxosa, Forst. Fl. March, April. Tararua Mountains.

Boragineæ.

Myosotis antarctica, Hook. f. Fl. Jan. ; white.
forsteri, Rœm. and Sch. Fl. Jan., Feb. ; white.

Convolvulaceæ.

Convolvulus sepium, Linn. Fl. Dec., Jan. ; white.
tuguriorum, Forst. Fl. Dec., Jan. ; white or pink.
soldanella, Hook. f. Fl. Nov.—Jan. ; white or pink.
erubescens, Br. Fl. Dec.—Feb. ; white or pink.
Dichondra repens, Forst. Fl. Dec.—Feb. ; greenish white.

Solaneæ.

Solanum aviculare, Forst. Fl. Oct.—Jan.; purple.
nigrum, Linn. Fl. Oct.—Jan; white.

Scrophularineæ.

Mimulus radicans, Hook. f. Fl. Nov., Dec.; bluish.
Mazus pumilio, Br. Otaki. Fl. Dec., Jan.; bluish.
Gratiola sexdentata, A. Cunn. Fl. Jan., Feb.
Limosella aquatica, var. *tenuifolia*, Linn. Lyall Bay.
Veronica salicifolia, Forst. Wairarapa. Fl. Sep., Oct.; white.
parviflora, Vahl. Wellington Harbour. Fl. Feb.—June; white.
arborea, sp. nov. Fl. Jan.—April; white or pale purple.
ligustrifolia, A. Cunn. Upper Rangitikei. Fl. Jan.; white.
lævis, Benth. Tararua Mountains. Fl. March; white.
tetragona, Hook. Tararua Mountains. Fl. Jan.; white.
nivalis, Hook. f. Patea country.
lyallii, Hook. f. Wanganui. Fl. Jan.; white.
cataractæ, Forst. Upper Wairarapa. Fl. Dec.
" var. *b. diffusa*. Tararua Mountains. White.
Ourisia macrophylla, Hook. Wainuiomata. Fl. Dec., Jan.; white.
colensoi, Hook. f. Upper Rangitikei. Fl. Jan.; white.
Euphrasia cuneata, Forst. Tararua Mountains, etc. Fl. March, April; white.
antarctica, Benth. Upper Wairarapa.

Gesneraceæ.

Rhabdothamnus solandri, A. Cunn. Horokiwi. Fl. Dec.—Feb.; striped red and yellow.

Lentibularieæ.

Utricularia novæ-zealandiæ, Hook. f. Wainuiomata. Fl. Jan.

Verbenaceæ.

Teucridium parvifolium, Hook. f. Upper Wairarapa. Not in flower.
Myoporum lætum, Forst. Fl. Oct.—Jan.; white, spotted pink.

Labiatæ.

Mentha cunninghamii, Benth. Wanganui. Fl. Jan.; white.

Plantagineæ.

Plantago brownii, Rapin. Manawatu.
raoulii, Decaisne. Upper Rangitikei.

Chenopodiaceæ.

Chenopodium triandrum, Forst. Fl. Dec., Jan.
glaucum, var. *ambiguum*. Fl. Dec., Jan.
carinatum, Br. Fl. Jan.
Suæda maritima, Dumont. Island Bay, Wellington.
Atriplex cinerea, Poiret. Evans Bay.
Salsola australis, Br. Pipitea Point, Wellington.
Salicornia indica, Willd. Evans Bay. Fl. Oct., Nov.

Paronychieæ.

Scleranthus biflorus, Hook. f. Fl. Dec.—Feb.; white.

POLYGONEÆ.

Polygonum minus, Huds., var. *decipiens*. Fl. Sept.—Dec.
aviculare, Linn. Fl. Oct.—Jan.
Muhlenbeckia adpressa, Lab. Fl. Oct.—March.
complexa, Meisn. Fl. Dec.—April.
axillaris, Hook. f. Upper Wairarapa.

LAURINEÆ.

Nesodaphne tawa, Hook. f. Fl. July, Aug.

MONIMIACEÆ.

Atherosperma novæ-zealandiæ, Hook. f. Fl. Dec., Jan.
Hedycarya dentata, Forst. Fl. Oct.—Dec.; greenish white.

PROTEACEÆ.

Knightia excelsa, Br. Fl. Nov., Dec.; red.

THYMELEÆ.

Pimelea virgata, Vahl. Upper Wairarapa. Fl. Nov., Dec.; white.
arenaria, A. Cunn. Fl. Dec.—April; white.
urvilleana, A. Rich. Fl. Jan., Feb.; white.
prostrata, Vahl. Fl. during the year; white.

SANTALACEÆ.

Santalum cunninghamii, Hook. f.

EUPHORBIACEÆ.

Euphorbia glauca, Forst. Fl. Aug.—Dec.

CUPULIFERÆ.

Fagus menziesii, Hook. f.
fusca, Hook. f.
solandri, Hook. f.

URTICEÆ.

Epicarpurus microphyllus, Raoul. Fl. Sept., Oct.
Urtica australis, Hook. f. Fl. Nov., Dec.
ferox, Forst. Fl. Nov., Dec.
Parietaria debilis, Forst.
Australina pusilla, Gaud. Fl. Oct., Nov.
Elatostemma rugosum, A. Cunn. Fl. Dec., Jan. Otaki.

PIPERACEÆ.

Peperomia urvilleanum, A. Rich. Fl. Aug., Sep.
Piper excelsum, Forst. Fl. Sep.—Nov.

CONIFERÆ.

Libocedrus doniana, Endl. Tararua Mountains.
Podocarpus ferruginea, Don. Fl. Oct.
nivalis, Hook. f. Tararua Mountains.
totara, A. Cunn. Fl. Oct.
spicata, Br. Fl. Oct.
dacrydoides, A. Rich.
Dacrydium cupressinum, Sol. Fl. Sept., Oct.
Phyllocladus trichomanoides, Don. Tararua Mountains.

MONOCOTYLEDONS.

ORCHIDEÆ.

Earina mucronata, Lindl. Fl. Oct., Nov.; white, spotted pink.
autumnalis, Hook. f. Fl. Feb., March; white.
Dendrobium cunninghamii, Lindl. Fl. Nov.—Jan.
Bolbophyllum pygmæum, Lindl.
Sarcochilus adversus, Hook. f. Fl. Dec.; yellowish green.
Gastrodia cunninghamii, Hook. f. Fl. Nov.; white.
Acianthus sinclairii, Hook. f. Fl. March. Wanganui.
Corysanthes triloba, Hook. f. Fl. Oct., Nov.; purple.
rotundifolia, Hook. f. Fl. Oct., Nov.; purple.
Microtis porrifolia, Spreng. Fl. Nov., Dec.; yellowish green.
Caladenia minor, Hook. f. Fl. Nov., Dec.; pale greenish white.
Pterostylis banksii, Br. Fl. Nov., Dec.; pale green.
graminea, Hook. f. Fl. June—Aug.; pale green.
micromega, Hook. f. Fl. Oct.—Dec.
Thelymitra longifolia, Forst. Fl. Nov., Dec.; white and purple.
colensoi, Hook. f. Fl. Nov., Dec.; yellowish green.
Prasophyllum colensoi, Hook. f. Fl. Nov., Dec.; yellowish green.
nudum, Hook. f. Fl. Nov., Dec.; yellowish green.
Orthoceras solandri, Lindl. Wainuiomata. Fl. Dec., Jan.; yellowish green

IRIDEÆ.

Libertia ixioides, Spreng. Fl. Sep.—Dec.; white.
micrantha, A. Cunn. Fl. Nov., Dec.; white.

PANDANEÆ.

Freycinetia banksii, A. Cunn. Fl. Sep., Oct.; white.

TYPHACEÆ.

Typha angustifolia, Linn. Fl. Dec.
Sparganium simplex, Huds. Fl. Dec.; white. Wanganui.

NAIADEÆ.

Lemna minor, Linn.
Triglochin triandrum, Mich. Fl. Dec., Jan.
Potamogeton natans, Linn. Fl. Dec.
gramineus, Linn.
Ruppia maritima, Linn.
Zannichellia palustris, Linn.
Zostera marina, Linn.

LILIACEÆ.

Rhipogonum scandens, Forst. Fl. Dec.; yellowish green.
Callixene parviflora, Hook. f. Wainuiomata.
Cordyline australis, Hook. f. Fl. Nov., Dec.; white.
banksii, Hook. f. Fl. Nov., Dec.; white.
indivisa, Kunth. Fl. Jan.; white.
pumilio, Hook. f. Fl. Jan.; white.
Dianella intermedia, Endl. Fl. Dec.
Astelia cunninghamii, Hook. f. Fl. Dec., Jan.
linearis, Hook. f. Upper Wairarapa. Not in flower.
solandri, A. Cunn. Fl. Jan., Feb.
grandis, Hook. f. Fl. Oct., Nov.

Arthropodium cirrhatum, Br. Fl. Nov., Dec.; white.
candidum, Raoul. Fl. Nov., Dec.; white.
Phormium tenax, Forst. Fl. Oct.—Dec.; dark brownish purple.
colensoi, Hook. f. Fl. Sept.—Dec.; pale yellow and red.

PALMEÆ.

Areca sapida, Sol. Fl. May, June.

JUNCEÆ.

Juncus
vaginatus, Br.
australis, Hook. f.
maritimus, Lam.
communis, E. Mayer.
planifolius, Br.
bufonius, Linn.

Juncus (continued).
novæ-zealandiæ, Hook. f.
capillaceus, Hook. f.
Luzula
campestris, DC.
,, var. *b.* (Wairarapa).
oldfieldii, Hook. f.

RESTIACEÆ.

Leptocarpus
simplex, A. Rich.

Calorophus
elongata, Labill.

CYPERACEÆ.

Cyperus
ustulatus, A. Rich.
Schœnus
axillaris, Hook. f.
tenax, Hook. f.
pauciflorus, Hook. f.
concinnus, Hook. f.
nitens, Hook. f.
Carpha
alpina, Br.
Scirpus
maritimus, Linn.
lacustris, Linn.
triqueter, Linn.
Eleocharis
gracilis, Br.
gracillima, Hook. f.
acuta, Br., var. *platylepis*.
ambigua, Kirk.
Isolepis
nodosa, Br.
prolifer, Br.
globosa, n. s.
riparia, Br.
cartilaginea, Br.
aucklandica, Hook. f.
Desmoschœnus
spiralis, Hook. f.
Cladium
glomeratum, Br.
junceum, Br.

Gahnia
setifolia, Hook. f.
procera, Forst.
ebenocarpa, Hook. f.
lacera, Steud.
Lepidosperma
tetragona, Labill.
Oreobilis
pumilio, Br.
Uncinia
leptostachya, Raoul.
sinclairii, Boott.
australis, Persoon.
cæspitosa, Boott.
filiformis, Boott.
Carex
pyrenaica, Wahl.
colensoi, Boott.
stellulata, Good.
teretiuscula, Good.
virgata, Sol.
,, var. *secta*.
ternaria, Forst.
raoulii, Boott.
lucida, Boott.
pumila, Thunb.
forsteri, Vahl.
cataractæ, Br.
dissita, Sol.

GRAMINEÆ.

Microlæna
stipoides, Br.
avenacea, Hook. f.
Alopecurus
geniculatus, Linn.
Hierochloe
redolens, Br.
Spinifex
hirsutus, Labill.
Panicum
imbecille, Trinius.
Echinopogon
ovatus, Palisot.
Dichelachne
crinita, Hook. f.
Agrostis
canina, Linn., var. *b.*
parviflora, Br.
æmula, Br.
billardieri, Br.
quadriseta, Br.
Arundo
conspicua, Forst.
fulvida, n. s.
Danthonia
cunninghamii, Hook. f.

Danthonia (continued)
raoulii, Steud.
semi-annularis, Br.
Kœleria
cristata, Persoon.
Trisetum
antarcticum, Palisot.
subspicatum, Palisot.
Glyceria
stricta, Hook. f.
Catabrosa
antarctica, Hook. f.
Poa
imbecilla, Forst.
anceps, Forst.
australis, Br.
colensoi, Hook. f.
Festuca
littoralis, Br.
duriuscula, Linn.
Bromus
arenarius, Lab.
Triticum
scabrum, Br.
Gymnostichum
gracile, Hook. f.

FILICES.

Gleichenia
dicarpa, Br.
cunninghamii, Hew.
Cyathea
dealbata, Swartz.
medullaris, Swartz.
cunninghamii, Hook. f.
Hemitelia
smithii, Hook.
Dicksonia
squarrosa, Swartz.
antarctica, Br.
Hymenophyllum
tunbridgense, Smith.
„ var. *a. minimum.*
„ var. *b. cupressiforme* and *unilaterale.*
bivalve, Swartz.
multifidum, Swartz.
rarum, Br.
pulcherrimum, Col.
javanicum, Spreng.
polyanthos, Swartz.
demissum, Swartz.

Hymenophyllum (continued)
scabrum, A. Rich.
flabellatum, Labill.
subtilissimum, Kuntze.
Trichomanes
reniforme, Forst.
humile, Forst.
colensoi, Hook. f.
venosum, Br.
rigidum, Swartz.
„ var. *b. elongatum.*
Davallia
novæ zealandiæ, Col.
Lindsaya
linearis, Swartz.
trichomanoides, Dryan.
„ var. *b. lessonii.*
Adiantum
hispidulum, Swartz.
diaphanum, Blume.
affine, Willd.
fulvum, Raoul.
Hypolepis
tenuifolia, Bernh.

Hypolepis (continued)
distans, Hook.
Pellæa
rotundifolia, Forst.
Pteris
aquilina, Linn., var. *g. esculenta.*
tremula, Br.
scaberula, A. Rich.
incisa, Thunb.
macilenta, A. Rich.
Lomaria
filiformis, A. Cunn.
procera, vars. *a., b., c., d.*
fluviatilis, Spreng.
membranacea, Col.
vulcanica, Blume.
patersoni, Spreng.
lanceolata, Spreng.
discolor, Willd.
alpina, Spreng.
banksii, Hook. f.
nigra, Col.
Doodia
caudata, Br.
„ var. *b. falcata* (scented).
Asplenium
obtusatum, Forst.
„ var. *c. lucidum.*
trichomanes, Linn.
flabellifolium, Cavan.
falcatum, Lam.
hookerianum, Col.
colensoi, Hook. f.
bulbiferum, Forst.
„ var. *b. laxa.*
„ var. *c. tripinnata.*
richardi, Hook. f.
flaccidum, Forst.
„ vars. *a., b., c., d.*
Aspidium
aculeatum, Swartz.
„ var. *b. sylvaticum.*
richardi, Hook.
oculatum, Hook.
cystostegia, Hook.
capense, Willd.
Nephrodium
velutinum, Hook f.
decompositum, Br.
„ var. *b. fasciculata.*
hispidum, Hook.
Polypodium
australe, Mett.
grammitides, Br.
tenellum, Forst.
rugulosum, Labill.
pennigerum, Forst.
serpens, Forst.
cunninghamii, Hook.
Polypodium
pustulatum, Forst.
billardieri, Br.
Gymnogramme
leptophylla, Desv.
Todea
hymenophylloides, Rich. and Less.
superba, Col.
„ var. *b. intermedia.*
Ophioglossum
vulgatum, Linn.
„ var. *b. costatum.*
lusitanicum, Linn.
„ var. *e. minimum.*
Botrychium
circutarium, Swartz.
„ vars. *a., b.*

LYCOPODIACEÆ.

Lycopodium
billardieri, Spreng.
laterale, Br.
scariosum, Forst.
Lycopodium (continued)
volubile, Forst.
Tmesipteris
forsteri, Endl.

MARSILEACEÆ.

Azolla rubra, Br.

CRYPTOGAMIA.

MUSCI.

Gymnostichum
calcareum, Nees and Horns.
Weissia
controversa, Hedw.

Weissia (continued)
flavipes, Hook. f. and Wils.
irroratum, Mitt.
rufa, Stirton.
Symblepharis
perichætialis, Wils.
Fissidens
asplenioides, Swartz.
tenellus, Hook. f. and Wils.
dealbatum, Hook. f. and Wils.
rigidulus, Hook. f. and Wils.
bryoides, Hedw.
viridulus, Wahl., var. *acuminatus*
" var. *incurvus*.
Dicneum
calycinum, Wils. and Hook.
Leucobryum
candidum, Hampe.
Dicranum
tasmanicum, Hook. f.
dicarpon, Hornsch.
robustum, Hook. f. and Wils.
" var. *b. pungens*.
fasciatum, Hedw.
billardieri, Brid.
setosum, Hook. f. and Wils.
menziesii, Tay.
Campylopus
introflexus, Hedw.
appressifolius, Mitt.
torquatus, Br.
Trematodon
suberectus, Mitt.
Trichostomum
leptodon, Mitt.
phæum, Hook. f. and Wils.
mutabile, Bruch.
laxifolium, Hook. f. and Wils.
elongatum, Hook. f. and Wils.
Tortula
muelleri, Br. and Schimp.
serrulata, Hook. and Grev.
rubra, Mitt.
knightii, Mitt.
calycina, Schwægr.
Ceratodon
purpureus, Brid.
Grimmia
apocarpa, Hedw.
pulvinata, Smith.
" var. *africana*.
trichophylla, Grev.
buchanani, Stirton.
Racomitrium
crispulum, Hook. f. and Wils.
protensum, Braun.
lanuginosum, Brid., var. *pruinosum*.
Schlotheimia
brownii, Schwægr.
Macromitrium
longipes, Schwægr.
gracile, Schwægr.
microphyllum, Hook. and Grev.
microstomum, Schwægr.
Zygodon
brownii, Schwægr.
menziesii, Mitt.
Leptostomum
inclinans, Br.
macrocarpum, Br.
Bryum
pyriforme, Hedw.
truncorum, Bory.
campylothecium, Tay.
obconicum, Horns.
lævigatum, Hook. f. and Wils.
chrysoneurum, C. Muell.
pachytheca, C. Muell.
torquescens, Bruch. and Schimp.
annulatum, Hook. f. and Wils.
contortum, Stirton.
Mnium
rostratum, Schwægr.
Conostomum
australe, Swartz.
Cryptopodium
bartramioides, Brid.
Bartramia
halleriana, Hedw.
papillata, Hook. f.
australis, Mitt.
divaricata, Mitt.
Funaria
hygrometrica, Hedw.
Physcomitrium
apophysatum, Tay.
pyriforme, Bruch. and Sch.
Eremodon
octoblepharis, Hook. f. and Wils.
" var. *c. major*.
Polytrichum
australe, Hook. f. and Wils.
magellanicum, Hedw.
tortile, Swartz.
juniperinum, Hedw.

Polytrichum (continued)
commune, Linn.
gracile, Menz.
Dawsonia
superba, Grev.
Fabronia
australis, Hook.
Leptodon
smithii, Brid.
Cladomnion
ericoides, Hook. f. and Wils.
Meteorum
molle, Hook. f. and Wils.
flexicaule, Hook. f. and Wils.
Cryaphæa
acuminata, Hook. f. and Wils.
Cyrtopus
setosus, Brid.
Phyllogonium
elegans, Hook. f. and Wils.
Neckera
pennata, Hedw.
lævigata, Hook. f. and Wils.
Trachyloma
planifolium, Brid.
Isothecium
pandum, Hook. f. and Wils.
arbuscula, Hook. f. and Wils.
ramulosum, Mitt.
angustatum, Mitt.
pulvinatum, Hook. f. and Wils.
gracile, Hook. f. and Wils.
spininervium, Hook. f. and Wils.
„ var. *b. arcuatum.*
marginatum, Hook. f. and Wils.
comosum, Hook. f. and Wils.
Entodon
truncorum, Mitt.
Hypnum
furfurosum, Hook. f. and Wils.
fulvastrum, Mitt.
sparsum, Hook. f. and Wils.
læviusculum, Mitt.
denticulosum, Mitt.
brachiatum, Mitt.
hispidum, Hook. f. and Wils.
joliffii, Mitt.
leptorhynchum, Brid.
chrysogaster, C. Muell.
cupressiforme, Linn.
mundulum, Hook. f. and Wils.

Hypnum (continued)
pulchellum, Dicks.
sandwichense, Hook. and Arnot.
muricatulum, Hook. f. and Wils.
austrinum, Hook. f. and Wils.
tenuifolium, Hedw.
amiantum, Stirton.
rutabulum, Linn.
wellingtonii, Stirton.
polygonum, Bruch. and Schimp.
aciculare, Labill.
clandestinum, Hook. f. and Wils.
chlamydophyllum, H. f. and Wils.
extenuatum, Brid.
politum, Hook. f. and Wils.
Omalia
pulchella, Hook. f. and Wils.
falcifolia, Hook. f. and Wils.
Rhizogonium
distichum, Brid.
pennatum, Hook. f. and Wils.
bifarium, Schimp.
mnioides, Hook. f. and Wils.
Hymenodon
piliferus, Hook. f. and Wils.
Hypopterygium
filiculæforme, Brid.
viridulum, Mitt.
novæ-zealandiæ, C. Muell.
glaucum, Sull.
tamariscinum, Sull.
ciliatum, Brid.
concinnum, Brid.
struthiopteris, Brid.
Cyathophorum
pennatum, Brid.
„ var. *b. minus.*
Calomnion
lætum, Hook. f. and Wils.
Racopilum
strumiferum, Hook. f. and Wils.
cristatum, Mitt.
lætum, Mitt.
Hookeria
pulchella, Hook. f. and Wils.
adnata, Hook. f. and Wils.
microcarpa, Hook. f. and Wils.
quadrifaria, Smith.
robusta, Hook. f. and Wils.
nigella, Hook. f. and Wils.
cristata, Arnot.

Hepaticæ.

Jungermannia
- (*Solenostoma*) *inundata*, H. f. and Tay.

Plagiochila
- *pleurota*, H. f. and Tay.
- *stephensoniana*, Mitt.
- *gigantea*, Lindb.
- *annotina*, Lindb.
- *dicksonii*, H. f. and Tay.
- *fasciculata*, Lindb.
- *deltoidea*, Lindb.
- *incurvicolla*, H. f. and Tay.
- *lyallii*, Mitt.

Leioscyphus
- *repens*, Mitt.

Lophocolea
- *triacantha*, H. f. and Tay.
- *novæ-zealandiæ*, Mitt.
- *australis*, Mitt.
- *bidentata*, Nees.
- *lenta*, H. f. and Tay.
- *muricata*, Nees.

Gottschea
- *unguicularis*, H. f. and Tay.
- *appendiculata*, Nees.
- *nobilis*, Nees.

Chiloscyphus
- *fissistipus*, H. f. and Tay.
- *supinus*, H. f. and Tay.
- *colensoi*, Mitt.
- *coalitus*, Nees.
- *physanthus*, Mitt.
- *piperitus*, Mitt.
- *echinellus*, Mitt.

Adelanthus
- *falcatus*, Mitt.

Lepidozia
- *microphylla*, Lindb.
- *capilligera*, Lindb.
- *lævifolia*, H. f. and Tay.
- *lindenbergii*, Gottsche.
- *capillaris*, Lindb.

Mastigobryum
- *tenacifolium*, H. f. and Tay.
- *involutum*, Lindb.
- *affine*, Mitt.

Isotachis
- *lyallii*, Mitt.
- *subtrifida*, H. f. and Tay.

Trichocolea
- *lanata*, Nees.
- *tomentella*, Nees.

Trichocolea (continued)
- *polycantha*, H. f. and Tay.

Sendtnera
- (*Leperoma*) *ochroleuca*, Nees.
- *flagellifera*, Nees.

Polyotus
- *clavigera*, Gottsche.

Radula
- *buccinifera*, H. f. and Tay.
- *uvifera*, H. f. and Tay.

Madotheca
- *stangeri*, Gottsche.

Lejeunia
- *olivacea*, H. f. and Tay.
- *anguiformis*, H. f. and Tay.
- *papillata*, Mitt.
- *cucullata*, Nees.
- *latitans*, H. f. and Tay.
- *tumida*, Mitt.

Frullania
- *squarrosula*, H. f. and Tay.
- *falciloba*, H. f. and Tay.
- *cranialis*, Tay.
- *spinifera*, H. f. and Tay.
- *deplanata*, Mitt.
- *reptans*, Mitt.
- *pentapleura*, H. f. and Tay.
- *hypoleuca*, Nees.
- *fugax*, H. f. and Tay.
- *congesta*, H. f. and Tay.
- (*Polyotus*) *allophylla*, H. f. and Tay.

Podomitrium
- *phyllanthus*, Mitt.

Symphyogyna
- *flabellata*, Montagne.
- *leptoda*, H. f. and Tay.
- *hymenophyllum*, Montagne.
- *subsimplex*, Mitt.

Metzgera
- *furcata*, Nees.

Aneura
- *alterniloba*, H. f. and Tay.
- *palmata*, Nees.
- *pinnatifida*, Nees.
- *multifida*, Dumort.
- *cochleata*, Mitt.
- *eriocaula*, Mitt.

Marchantia
- *tabularis*, Nees.
- *nitida*, Lehm. and Lindb.
- *macropora*, Mitt.

Dumortiera
hirsuta, Nees.
Fimbriaria
tenera, Mitt.

Nitella
hyalina, Agardh.

Collema
nigrescens, Ach.
fasciculare, Ach.
Leptogium
scoticum, Fries.
tremelloides, Fries.
chloromellum, Nyl.
bullatum, Nyl.
Sphærophoron
compressum, Ach.
coralloides, Pers.
tenerum, Laur.
Bæomyces
rufus, DC.
roseus, Pers.
pertenuis, Stirton.
granosus, sp. nov.
subgranosus, sp. nov.
arcuatus, sp. nov.
Cladonia
pyxidata, Fries.
cariosa, Flœrke.
capitellata, Bab.
furcata, Hoffm.
rangiferina, Hoffm.
aggregata, Esch.
retipora, Flœrke.
cornucopioides, Fries.
digitata, Hoffm.
Stereocaulon
colensoi, Bab.
ramulosum, Ach.
Usnea
barbata, Fries.
„ var. *florida*.
„ var. *ceratina*.
„ var. *trichodea*.
melaxantha, Ach.
Alectoria
ochroleuca, Nyl.
Ramalina
calicaris, Fries.
„ var. *praxinea*.
„ var. *farinacea*.
„ var. *pusilla*.

Fimbriaria (continued)
australis, H. f. and Tay.
Anthoceros
lævis, Linn.

CHARACEÆ.

Nitella
hookeri, Braun.

LICHENES.

Nephroma
australe, A. Rich.
Peltigera
polydactyle, Hoffm.
Sticta
fragillima, Bab.
hookeri, Bab.
crocata, Ach.
carpoloma, Delise.
filicina, Ach.
variabilis, Ach.
cinereo-glauca, Tay.
orygmæa, Ach.
urvillei, Delise.
aurata, Ach.
fossulata, Dufour.
freycinetia, Delise.
dissimulata, Nyl.
hirta, Stirton.
Ricasolea
coriacea, Nyl.
montagnei, Nyl.
Parmelia
caperata, Ach.
perforata, Ach.
perlata, Ach.
olivacea, Ach.
physodes, Ach.
pertusa, Schærer.
angustata, Pers.
chrysophthalma, DC.
parietina, Ach.
cæsia, Ach.
Psoroma
sphinctrinum, Nyl.
„ var. *crispellum*.
arthroophyllum, Stirton.
implexa, Stirton.
Pannaria
crustata, Stirton.
immixta, Nyl.
parfossa, sp. nov.
variegata, sp. nov.
Squammaria
gelida, Delise.

Squammaria (continued)
thaumaster, Stirton.
Phlyctis
uncinata, sp. nov.
subuncinata, sp. nov.
oleosa, sp. nov.
Lecanora
cerina, Ach.
chrysosticta, Tay.
subfusca, Nyl., var. *argentata.*
varia, Ach.
argopholis, Nyl.
atra, Ach.
homologa, Nyl.
thiomela, Nyl.
vallata, sp. nov.
flavopallida, sp. nov.
Pertusaria
subverrucosa, Nyl.
circumcincta, sp. nov.
Thelotrema
lepadinum, Ach.
obovatum, Stirton.
hians, sp. nov.
Ascidium
elatius, sp. nov.
Cœnogonium
linkii, Ehrenb.
Lecidea
marginiflexa, Tay.
contigua, Fries.
stellulata, Tay.
flavido-atra, Nyl.
rivulosa, Ach.
coarctata, Nyl.
otagensis, Nyl.
melanotropa, Nyl.
myriocarpa, DC.
grossa, Pers.
fuscolutea, Dicks.
denigrata, Nyl.
millegrana, Tay.
luteola, Ach.
kelica, Stirton.
campylospora, Stirton.
maculosa, Stirton.
insidens, Stirton.
implicata, Stirton.
fuscocincta, sp. nov.
keratina, sp. nov.

Lecidea (continued)
epibysa, sp. nov.
aleuroides, sp. nov.
rubicundula, sp. nov.
nidulans, sp. nov.
wellingtonii, sp. nov.
nubilior, sp. nov.
Graphis
scripta, Ach.
,, var. *serpentina.*
puiziana, sp. nov.
Opegrapha
varia, Pers.
herpetica, Ach., var. *rubella.*
Platygraphis
inconspicua, Knight and Mitt.
Chiodecton
conchyliatum, sp. nov.
moniliatum, sp. nov.
sinuosum, sp. nov.
Arthonia
polymorpha, Ach.
ampliata, Knight and Mitt.
goniiza, sp. nov.
perangusta, sp. nov.
Melaspila
amphorodes, Stirton.
Trypethelium
madreporiforme, Esch.
cumingii, Mitt.
connivens, Nyl.
erumpens, Fée.
Astrothelium
prostratum, Stirton.
Verrucaria
maura, Wahl.
nitida, Schrad.
glabrata, Ach.
subtrahens, Nyl.
cyrtospora, Stirton.
leptiza, sp. nov.
belonize, sp. nov.
Tremotylium
occultum, sp. nov.
suboccultum, sp. nov.
Odontotrema
concentricum, sp. nov.
Thelonella
wellingtonii, Stirton.

FUNGI.

Agaricus
cartilagineus, Bulliard.

Agaricus
erebius, Fries.

Agaricus (continued)
- *campestris*, Linn.
- *arvensis*, Schœff.
- *semiglobatus*, Batsch.
- *stuppeus*, Berk.

Coprinus
- *colensoi*, Berk.

Marasmius
- *caperatus*, Berk.

Lentinus
- *novæ-zealandiæ*, Berk.

Panus
- *stypticus*, Fries.

Schizophyllum
- *commune*, Fries.

Lentzites
- *repanda*, Fries.

Polyporus
- *phlebophorus*, Berk.
- *igniarius*, Fries.
- *iridioides*, Berk.
- *versicolor*, Fries.
- *sanguineus*, Fries.

Dædalea
- *pendula*, Berk.

Favolus
- *intestinalis*, Berk.

Stereum
- *phæum*, Berk.

Corticum
- *tenerum*, Berk.
- *polygonium*, Fries.

Cyphella
- *densa*, Berk.

Clavaria
- *lutea*, Vitt.
- *flagelliformis*, Berk.
- *arborescens*, Berk.

Hirneola
- *auricula-judæ*, Berk.
- *hispidula*, Berk.

Aseroe
- *rubra*, Labill.

Ileodictyon
- *cibarium*, Tulas.

Secotium
- *erythrocephalum*, Tulas.

Paurocotylis, sp.

Geaster
- *fimbriatus*, Fries.

Bovista
- *brunnea*, Berk.

Lycoperdon
- *cœlatum*, Fries.
- *reticulatum*, Berk.
- *microspermum*, Berk.

Scleroderma
- *geaster*, Fries.

Æthalium
- *septicum*, Fries.

Cyathus
- *colensoi*, Berk.

Crucibulum
- *vulgare*, Tulas.

Phoma
- *acmella*, Berk.

Uromyces
- *citriformes*, Bab.

Ustilago
- *endotricha*, Berk.
- *bullata*, Berk.

Æcidium
- *ranunculacearum*, DC.

Peziza
- *stercorea*, Fries.
- *kerguelensis*, Berk.

Cordiceps
- *robertsii*, Berk.

Nectria
- *polythalama*, Berk.
- *illudens*, Berk.

Antennaria
- *robinsonii*, Mont.

ALGÆ.

MELANOSPERMEÆ.

Sargassum
- *longifolium*, Ag.
- *plumosum*, A. Rich.
- *sinclairii*, H. f. and Harv.
- *bacciferum*, Ag.

Carpophyllum
- *phyllanthus*, H. f. and Harv.
- *maschalocarpum*, H. f. and Harv.

Marginaria
- *boryana*, A. Rich.
- *urvilleana*, A. Rich.

Phyllospora
- *comosa*, Ag.

Scaberia
- *agardhii*, Grev.

Cystophora
monilifera, Ag.
retroflexa, J. Ag.
Landsburgia
quercifolia, Harv.
Fucodium, J. Ag.
gladiatum, J. Ag.
chondrophyllum, J. Ag.
Hormosira
billardieri, Mont.
„ var. *sieberi*, Harv.
Splachnidium
rugosum, Grev.
Notheia
anomala, Bailly and Harv.
D'Urvillæa
utilis, Bory.
Carpomitra
cabreræ, Kuetz.
halyseris, H. f. and Harv.
Macrocystis
pyrifera, Ag.
Lessonia
fuscescens, Bory.
Ecklonia
radiata, J. Ag.
Zonaria
sinclairii, H. f. and Harv.
interrupta, Ag.
velutina, Harv.
Dictyota
kunthii, Ag.
dichotoma, Lamour.
Asperococcus
sinuosus, Bory.
Chorda
lomentaria, Lyndb.
Adenocystus
lessonii, H. f. and Harv.
Scytothamnus
australis, H. f. and Harv
Chordaria
sordida, Bory.
Mesogloia
intestinalis, Harv.
Sphacelaria
paniculata, Suhr.
funicularis, Mont.
pulvinata, H. f. and Harv.

RHODOSPERMEÆ.

Rhytiphlœa
delicatula, H. f. and Harv.
Rhodomela
gaimardi, Ag.
cæspitosa, Harv.
glomeratula, Mont.
Polysiphonia
rudis, H. f. and Harv.
lyallii, H. f. and Harv.
aterrima, H. f. and Harv.
Polyzonia
harveyana, Decaisne.
Laurencia
virgata, J. Ag.
Cladymenia
oblongifolia, Harv.
Amphiroa
corymbosa, Decaisne.
elegans, H. f. and Wils.
Corallina
armata, H. f. and Harv.
Jania
cuvieri, Decaisne.
micrarthrodia, Lamour.
gracilis, Lamour.
Melobesia
patena, H. f. and Harv.
antarctica, H. f. and Harv.
Delessaria
hookerii, Lyall.
Nitophyllum
uncinatum, J. Ag.
palmatum, Harv.
suborbiculare, Harv.
Gracilaria
multipartita, var. *polycarpa*, Harv.
coriacea, Harv.
Caulacanthus
spinellus, Kuetz.
Pterocladia
lucida, J. Ag.
Apophlœa
sinclairii, Harv.
Rhodophyllis
angustifrons, Harv.
Rhodymenia
prolifera, Harv.
dichotoma, H. f. and Harv.
Plocamium
costatum, H. f. and Harv.
concinnum, Lyndb.

Plocamium (continued)
procerum, J. Ag.
Gymnogongrus
furcellatus, J. Ag.
vermicularis, J. Ag.
Callophyllus
asperata, Harv.
Gigartina
decipiens, Hook. f.
Iridæa
micans, Bory.
lanceolata, Harv.
Epymenia
obtusa, Kuetz.
Chylocladia
cæspitosa, Harv.
Ceramium
uncinatum, Harv.
Ptilota
formosissima, Mont.
Griffithsia
antarctica, H. f. and Harv.
Ballia
callitricha, Mont.

CHLOROSPERMEÆ.

Caulerpa
sedoides, Ag.
brownii, Endl.
furcifolia, H. f. and Harv.
Codium
tomentosum, Ag.
adhærens, Ag.
Bryopsis
plumosa, Ag.
Porphyra
lacinata, Ag.
capensis, Kuetz.
Ulva
latissima, Linn.
rigida, Ag.
crispa, Lightf.
bullosa, Roth.
Enteromorpha
intestinalis, Grev.
clathrata, Grev.
Conferva
darwinii, Kuetz.
Chroolepus
aureus, Harvey.

ART. XXXIX.—*Descriptions of some New Zealand Lichens, collected by John Buchanan in the Province of Wellington.* By JAMES STIRTON, M.D., Glasgow. Communicated by JOHN BUCHANAN.

[*Read before the Wellington Philosophical Society, 16th January,* 1874.]

Bæomyces pertenuis, Stirton.

THALLUS scarcely discernible; apothecia pale buff, concave, with a paler border, attached by a central axis; spores eight, exceedingly minute, elongate-elliptical, apparently simple, although there are occasional indications of a septum which a $\frac{1}{8}$ objective cannot distinctly resolve, in nearly single file in asci, which scarcely differ in size or thickness from the ordinary paraphyses. A section presents the characteristic appearance of lichens of this genus. In such an extreme case as this, it is necessary to remark that I have carefully discriminated between the oil globules that are seen in the paraphyses of one or two of the species of this genus and these minute spores, which still preserve their outline when free of the asci, and which, by the aid of a better objective, I find now are nearly constantly three-septate.

On trunks of tree-ferns, Botanical Garden, Wellington.

Sticta hirta, Stirton.

Notwithstanding the varied forms assumed by *Sticta urvillei*, I am tempted to elevate into the rank of a species one of the several specimens sent.

Thallus widely expanded, reticulate-foveolate, broadly and roundly lobed, covered in many places with dense clusters of yellow isidiose efflorescence, under surface dark brown, densely tomentose; apothecia reddish brown merging into black, margin composed of a mass of radiating isidiose excrescence, which, in many instances, almost covers the disk; spores as in the variety *colensoi*.

On bark of trees, Kaka Hill, Wellington.

Psoroma implexa, Stirton.

Thallus yellowish brown, smooth above, closely adherent, intricately divided into small lobes, which are roundly lacinated, under surface white, tomentose (much more so than usual), attached to the bark by a dense mass of coarse, stiff, black, branching rhizinæ, which extend considerably beyond the thallus; apothecia moderate, brown, surrounded by a deeply incised lobular inflexed thalline margin, which, in a young state, almost conceals the disk; spores eight, simple, elliptical, moderate; paraphyses not discrete, agglutinate at their apices; hypothecium yellowish brown, grumous.

I have given a rather minute description of a lichen which has puzzled me considerably, mainly for the purpose of calling attention to it, as I cannot pretend to an intimate knowledge of this intricate and perplexing genus. The chemical reactions of K and C on the upper surface and medulla are (K—C—).

On rocks, Tinakori Hills, Wellington.

Psoroma arthroophyllum, Stirton.

Thallus greyish brown, thick, continuous, brownish black, and rough on the under surface, multifido-laciniate above; laciniæ closely imbricated, ascending, broad, margins roundly crenate, their under surface somewhat paler; apothecia large, rufous, rugose margin elevated, granuloso-concrete; spores eight, colourless, spherical, crenulate, in nearly single file in asci; paraphyses indistinct.

This may be *Psoroma euphyllum* (Nyl.), of which no description is given in the "Flora of New Zealand," nor in any of the later papers to which I have access.

On bark of trees, Tinakori Hills, Wellington.

Pannaria crustata, Stirton.

Thallus dark greenish olive, squamuloso-crustaceous, areolate-diffract; squamules largish, rugose, round, with crenulate turned-up margins; hypothallus black, evident; apothecia reddish brown, moderate, flat, or somewhat

convex when matured, with a proper margin of same colour, and an elevated crenated thallodal margin, which is often separated from the former by a chink, pale within; hypothecium pale brown; epithecium brownish; paraphyses matted together at apices; spores eight, simple, ellipsoid, or more frequently one or other, or both apices acute; margins distinctly crenulate, moderate (·014 × ·008*mm*).

On stones, Wellington.

Squamaria thaumasta, Stirton.

Thallus greyish white, tesselato-areolate, consisting of roundish umbonate particles closely set together, and yet quite distinct; cephalodia large, reddish brown, cracked in a radiating manner, and roundly lobed at the circumference; apothecia small, elevato-sessile, concave, reddish brown, rugose, with an elevated, smooth, inflexed border; spores eight, colourless, broadly elliptical, uniserial, one-septate. A beautiful lichen, and one that might constitute the type of a new genus.

On rocks and stones, Tinakori Hills and Kaiwarra Creek, Wellington.

Squamaria gelida, Linn.

The apothecium of this lichen is differently constituted from that in Britain, inasmuch as the thalline exciple resembles the cup of the acorn, while there is a proper border, smooth and prominent, surrounding the epithecium, which is itself white, pruinose, and rugose. I can see, however, little difference otherwise to warrant a separation.

On rocks and stones, Kaiwarra Creek and Hutt Road, Wellington.

Thelotrema obovatum, Stirton.

The spores of this lichen differ in shape from those of *Th. lepadinum*, and have altogether an appearance so peculiar that I have been tempted to elevate it into the rank of a species under the name given above. Thallus yellow, rimulose, uneven, slightly nodulated; apothecia hemispherical, crowded in some parts; ostiolum rounded, open, margin even; disk urceolate, scutilliform, dark brown, proper margin inflexed; spores eight, colourless, obovate, sharp pointed at one end, rounded at the other, divided internally by numerous crossbars, which do not reach the margin; epispore beautifully crenulated.

These characteristics are constant, at least in every specimen examined. I have not seen *T. subtile*, but, judging from the description of it by Leighton in his Lichen Flora, I cannot reconcile myself to identifying the present plant with it.

On bark of trees, Tinakori Hills, Wellington.

Lecidea kelica, Stirton.

Thallus greyish white, thin, minutely rimuloso-areolate; areolæ smooth,

flat, or somewhat convex (K—C—); apothecia bright yellow (K red), convex, immarginate, generally clustered and then deformed; hypothecium pale; spores eight, straight or curved, colourless, elongato-elliptical, almost subcylindrical, one-septate; paraphyses indistinct, with reddish brown apices.

This lichen is peculiar in having attached to the hypothecium, or indeed forming part of it, little cushions composed of green granular matter, not gonidiac cells, but rather as if their granular contents were set-free granular gonima, in fact; so that a microscopic preparation capable of showing the asci and spores has, to the naked eye, a bright lemon colour throughout. I cannot see the slightest trace of a margin even in very young apothecia, and, as the reaction is always as indicated above, I have no doubt this lichen is distinct, although it has certain affinities to *L. ehrhartiana* (Ach).

On bark of trees, Wainuiomata, Wellington.

Lecida campylospora, Stirton.

Thallus, in one specimen, white or greyish white, thin, continuous, almost papery (K—C—); in another, of a darker dingier colour, rimulose-areolate, areolæ flat or convex and somewhat granulate. Apothecia elevato-sessile; concave and contracted in a young state, afterwards expanded and flat, or even somewhat convex; cæsio-pruinose border thick, rounded, and inflexed; spores four, six, or eight, colourless, very large, bent at middle, one-septate with—in many instances—nuclei in the loculi, epispore crenulate; paraphyses dense, capillary; hypothecium pale yellow, grumous, subtended by the dense black receptacle. This is evidently allied to *L. marginiflexa* (Taylor), although quite distinct.

On bark of trees, Kaka Hill, Wellington.

Lecidea maculosa, Stirton.

Thallus whitish, thin, determinate, continuous or slightly rimulose, somewhat rugulose (Ky Cy); hypothallus black; apothecia black, sessile, flat, moderate, separate or conjoined, with a prominent black margin; spores eight, colourless, the great majority curved, ellipsoid, one-septate ·016 × ·007*mm*; paraphyses slender, distinct, with black, very much enlarged, club-shaped extremities, which are matted together; thalamium pellucid; hypothecium a beautiful reddish brown, subtended by a pale stratum which rests on the black entire exciple.

On bark of trees, Tinakori Hills, Wellington.

Melaspilea amphorodes, Stirton.

Thallus dark ashy grey, rimulose, thin; apothecia small, black, prominent, flat in a young state, and smooth, with à slight border; convex immarginate and rugose, when mature. Section of apothecium pale throughout, seated on a brownish grumous stratum; paraphyses scattered, distinct, colourless,

filiform, densely matted together at their thickened apices; asci pyriform, lower extremity attenuated and easily detached, walls composed of a double hyaline membrane, with a broad intervening space resembling—in this respect—the epispore in *L. sanguinaria;* spores large, four, six, or eight, oblong-cylindrical, multiseptate, with longitudinal septa.

A remarkable phenomenon is seen in a microscopical preparation of this lichen of some months' standing, viz., filaments are seen arising from many detached spores—first, from the extremities; second, from the septa, or in a line with them. Whether this is the result of germination I cannot determine, as I have very few apothecia left and do not care to destroy more until I see whether it is possible to secure other specimens.

A very distinct and curious lichen.

On bark of trees, Tinakori Hills, Wellington.

Lecidea insidens, Stirton.

Thallus white, smooth, investing the leaves of *Dicranum menziesii* with a continuous layer, to which, also, the apothecia are attached by a central point; apothecia reddish brown, rugose, plane, surrounded by a smooth prominent border of the same colour; hypothecium pale red, grumous; spores eight, colourless, spherical, muralilocular; paraphyses discrete.

The spores are muralilocular, and not merely coarsely granular, while their outline, when free, is in the great majority of cases circular, although a few are to be seen somewhat oblong. The paraphyses are thickened at their apices, where they are of a brown colour and matted together.

Wainuiomata, Wellington.

Lecidea implicata, Stirton.

Thallus white, smooth, thin, glaucous, rimulose (K—C—); apothecia large, sessile, flat or somewhat convex, pale buff colour, pruinose, rugose, border smooth, somewhat inflexed; paraphyses distinct, filiform, densely matted together, and giving off lateral filaments; hypothecium yellowish brown; spores eight, colourless, elliptical, large, coarsely granular. Disk of apothecia rendered slightly darker by K, but not red. This lichen has a proper margin, and as the apothecium is attached by a broad central basis, the thalline receptacle is seen covering it and the unattached portion, but ceases considerably below the proper margin. Spores ·043 × ·021*mm.*

On bark of trees, Karori Hills, Wellington.

Lecidea contigua, Fr.

A curious form growing on earth. The apothecia are sessile, and arranged in beautiful concentric rings; the border sharply defined and flat, being set at an angle to the surface—a disposition seen in a certain proportion of New

Zealand crustaceous lichens. The internal organization resembles exactly that so characteristic of this lichen.

On banks, Tinakori Hills, Wellington.

Lecidea fuscolutea, Dicks.

The chemical reactions are identical, viz., K, thallus yellow; apothecia crimson. The hypothecium is darker than in specimens from Ben Lawers, Scotland.

On bark of trees, Tinakori Hills, Wellington.

Lecidea otagensis? Nyl.

Thallus greyish white, smooth, thin, and nearly continuous; apothecia black, sessile, slightly concave, margined, afterwards slightly convex and immarginate, and somewhat rugose; spores eight, irregularly fusiform, thicker at one end, and shaped like an Italian *f*; septa varying from two to six; hypothecium pale; paraphyses not distinct, their apices black and closely matted together, as in many others of the New Zealand lichens.

The shape of the spores, as indicated above, is constant throughout several specimens examined, and it is noticeable that the curve at the thicker end is invariably that of a shorter radius vector.

Until I saw Dr. Lauder Lindsay's paper, in the "Edinburgh Philosophical Transactions," on lichens and fungi of New Zealand, I felt satisfied in identifying this lichen with *L. otagensis* from Dr. Nylander's description; but the shape of the spores, as figured by Dr. Lindsay, is quite at variance with what I have seen and described. The whole of a thin section has a dingy aspect, and the hypothecium is not dingier than the rest, perhaps more pellucid.

On bark of trees everywhere round Wellington.

Lecidea rivulosa, Ach.

So far as I know, this is the first notice of this common lichen having been found in New Zealand. It differs in no essential from specimens found in Britain.

Astrothelium prostratum, Stirton.

Thallus well developed, continuous or rimulose, thin, yellowish white, merging into grey or cinereous; apothecia compound; receptacle black, large, broad (·02 to ·07 in.), shallow, scarcely raised above the general surface; perithecia entire, irregular in outline, and all apparently opening into one ostiole, which shows on the surface; spores eight, uniserial, colourless at first—when the contents are coarsely granular—becoming brown when mature, with six crossbars, which assume the appearance of oval, coloured cells; paraphyses plentiful, filiform, simple.

On bark of trees, Wainuiomata, Wellington.

J.B. del et lith

SENECIO ROBUSTA. n.s.
nat. size.

RUBUS PARVA. n.s.
nat. size.

Trypthelium connivens, Nyl.

The spores of the specimens sent, instead of remaining colourless as Nylander states, turn ultimately to a brownish black, and the ostiolum shows a beautiful orange instead of being nigrescent—differences which, although worthy of remark, scarcely constitute a specific distinction.

On bark of trees, Karori Hills, Wellington.

Thelonella wellingtonii, Stirton.

Thallus a dirty brownish cream colour, thick, continuous, smooth; apothecia large, immersed; perithecium entire, globose; epithecium depressed, dark brown, poriform; spores eight, colourless, very large, oblong, fusiform, acutely pointed, murali-reticulate, enveloped in a double hyaline membrane, which is most perceptible in a young state, when also the contents are coarsely granular; paraphyses distinct, filiform, numerous. A very remarkable lichen.

On bark of trees, Tinakori Hills, Wellington.

Verrucaria cyrtospora, Stirton.

Thallus white, smooth, glabrous; apothecia black, prominent, subglobose; perithecium entire; spores eight, narrowly fusiform, curved, brown, with four to eight rectangular nuclei (·03 × ·004*mm*); paraphyses long, filiform, occasionally branched.

On bark of trees, Tinakori Hills, Wellington.

ART. XL.—*On some New Species of New Zealand Plants.*

By JOHN BUCHANAN, of the Geological Survey of New Zealand.

Plates XXII, XXIII.

[*Read before the Wellington Philosophical Society, 22nd September*, 1873, *and 26th January*, 1874.]

Olearia excorticata, n. s.

A small, much branched, subalpine shrub-tree 12–15 feet high, trunk 1 foot diameter. Branches covered with loose papery bark. Branchlets, petioles, leaves below, and panicle, covered with whitish buff tomentum. Leaves shortly petioled, 1–4 inches long, narrow, oblong, acuminate at both ends, 1 inch broad, flat, margins bluntly sinuate, glabrous, dark green and finely reticulate above, thinly coriaceous, lateral nerves nearly at right angles to mid-rib, but not prominent. Panicles axillary, few-flowered, corymbose, peduncles elongate, branches and branchlets capillary. Flower-heads small, campanulate, involucral scales few, inner row linear, obtuse, outer row much shorter, oblong, acuminate, pubescent. Florets 12–14, very small. Pappus

in one row, hairs thickened at the tips. Achene ribbed, compressed, pubescent.

Collected by Mr. Mitchell, surveyor, October, 1872, on the Tararua Mountains, Wellington.

This plant is allied in flower and fruit to *Olearia lacunosa*, differing entirely, however, in the flat, thin, broad leaves, without lacuna, smaller sparse-flowered, axillary panicles, and absence of reddish tomentum.

Another shrub was also collected in the same locality, but without flowers, having leaves 6–8 inches long and only ¼ inch broad; deeply pitted at the prominent right-angled veinlets, which, if not a young plant of *Olearia lacunosa*, may prove to be another new species of *Olearia*.

Veronica arborea, n. s.

A small tree 10–25 feet high, trunk 3 feet diameter. Leaves erect or reflected, 1–1½ inches long, linear lanceolate, acute, ⅙ inch broad, arranged in fascicles at the ends of the ultimate twigs. Racemes seldom longer than the leaves, close, small flowered, pubescent, pedicels short, sepals ovate, obtuse, ciliate, corolla ⅙ inch diameter. Capsule ⅛ inch long, twice as long as the calyx, swollen. This relic of the ancient bush may still be found in the neighbourhood of Wellington, in the rough bush country near Makara and Terawiti. Its form, when young, is peculiarly striking, being then perfectly dome-shaped, and elevated on a long, narrow stem, 10–12 feet high.

This is probably the plant alluded to in the Handbook as a small-leaved form of *Veronica parviflora*;* the smallest-leaved forms of the latter, however, can always be distinguished, and are never found except as straggling shrubs, a few feet high in open country. The racemes, also, are generally twice as long as the leaves.

Arundo fulvida, n. s.

Plant forming tussocks of close-growing leaves and culms. Leaves coriaceous, 5–6 feet long, narrow, with long, attenuate curving points, entire, and smooth, without cutting edges, upper surface covered more or less with long, silky hairs. Culms few, 4–6 feet long, with erect, broad, compacted, pale fulvous panicles, 12–18 inches long. Spikelets 1–2, flowered, closely arranged on capillary pedicels, empty glumes ⅓ inch long, nearly equal; flowering glumes two-thirds as long, not bifid at the points, but terminated by a slightly twisted not included awn.

The *Arundo conspicua*, of the New Zealand Flora and Handbook, has been at various times differently named by different botanists, and Baron von

* See Trans. N.Z. Inst., Vol. I., Art. X., p. 148, "On the Botany of the Great Barrier Island," by Mr. Kirk, where a similar plant is described, but not named. It has been named at this time for the convenience of many persons who cultivate the species in their gardens, and who repudiate its being *V. parviflora*.

Mueller, in his criticism of the genus (Chatham Island Flora), thinks it probable that some of them may have been describing varieties of the species. Dr. Hooker, again, in not recognizing more than one species, seems to consider the others not founded on sufficient *data*. It is, therefore, with some hesitation that the present is advanced as more than a variety. The differences, however, between this plant and *Arundo conspicua* are so great, particularly in its low habit of growth and dense-flowered, erect, fulvous panicle, that it has for many years attracted attention, and indeed some species of *Agrostis* and *Poa* rest on less distinction.

Collected by Dr. Menzies on the Mataura River, Otago, in 1867; and by J. Buchanan at Wellington Heads, in 1873.

Senecio robusta, n. s.

A small, woody, robust shrub, branches covered with scales formed by the sheathing bases of the old petioles, leaves below and petioles covered with thin, appressed, buffy white tomentum. Leaves petioled, 1–1¾ inch long, oblong ovate, or obovate and acuminate at bottom, rounded at top, margin entire, glabrous, and wrinkled above, coriaceous, the two lower nerves springing from near the bottom and running parallel with the margin for three-fourths of the leaf's length. Petioles ¼–½ inch long, flattening into sheaths at bottom, corymbs erect, spherical, of 5–7 yellow heads on robust, erect, terminal, bracteate peduncles; bracts linear, obovate, petioled; bracteoles nearly as long as the pedicels, very narrow, linear, acuminate, peduncle, pedicels and bracts below covered with appressed tomentum. Heads campanulate, ¾ inch across; involucral scales in one row ¼ inch long, linear acuminate, borders membranous, sparsely woolly, and terminated by a small tuft of hairs; rays ½ inch long, revolute; anthers tailed; pappus hairs in one row, white, scabrid. Achene glabrous, slightly grooved.

Collected by Mr. J. Morton on Mount Eglinton, Southland, 1873.

Plate XXII., fig. 1—Plant nat. size.

Allied to *Senecio monroi* and *Senecio laxifolia*, but differing very much from both in habit of growth, very coriaceous leaves with peculiar venation, and small robust corymbs of few large heads of flowers.

Carex appressa, Brown.

New to New Zealand.

Collected by Dr. Hector in Milford Sound, January, 1873. Hitherto found only in the Auckland and Campbell Islands.

Rubus parva, n. s.

A small, prostrate shrub, branches rooting, smooth, unarmed. Leaves simple, alternate, petiole 1 inch long, leaves 1–2 inches long, ¼ inch broad, linear, deeply serrated; back of mid-rib with 2–6 large, nearly straight spines; petioles, mid-rib, and bottom of serratures with a few scattered stiff hairs.

Flowers few, in short terminal panicles, or solitary with an opposite leaf; peduncles and pedicels pubescent; bracts narrow, entire; sepals tapering to a long narrow point, soon reflected, 3 lines long, pubescent on both sides, and ciliate. Petals white, shorter than the calyx. Fruit oblong, tapering, the length equal to one and a half times the breadth, succulent. Carpels numerous, angled, with a long persistent style.

Collected by Dr. Hector on the "Paddock," Lake Brunner, West Coast of the South Island, December, 1873, where it is found growing close to the ground, and covering large patches. The fruit has been made into preserves, and is also eaten by birds.

This diminutive *Rubus* differs from all the varieties of *Rubus australis* found in New Zealand in its habit of growth and alternate simple leaves, and might, from its delicious fruit, be worthy of culture.

Plate XXII., fig. 2—Female plant with imperfect fruit; fig. 3—Male plant in flower.

Senecio hectori, Buchanan. Trans. N.Z. Inst., V., 348.

Plants brought by Dr. Hector from the native locality of this striking species have succeeded well in the Colonial Botanic Garden at Wellington, and have attained a height of 3 feet, but, as yet, show no sign of flowering.

The accompanying illustration of this plant (Pl. XXIII.) is from fresh specimens received, through the kindness of Mr. McGregor, from the Upper Buller Valley.

Art. XLI.—*Notice of an Undescribed Species of* Cordyline.

By T. Kirk, F.L.S.

[*Read before the Auckland Institute, 8th December,* 1873.]

With the *Dracæna indivisa* discovered in Dusky Bay, by Forster, another form has hitherto been confused—the Toii of the North Island—a plant which, even from the scanty information we at present possess, appears to differ widely from the *Cordyline indivisa* of the Handbook, the description of which was chiefly drawn from the South Island specimens collected by Forster, and to which the North Island specimens, sent to Kew by Colenso, were referred by Dr. Hooker. In order to attract the attention of botanists to the North Island plant, I purpose offering a brief diagnosis drawn from the scanty material already collected, under the provisional name of *Cordyline hookeri*, in the hope of being thereby enabled to procure *data* for a complete description at some future time.

J.B. del. et lith.

SENECIO HECTORI. n. s.

nat. size

At the outset, however, it is certain that neither *C. indivisa* of Dusky Bay, nor *C. hookeri* of the North Island, exhibit uniformly simple stems, as stated in the Handbook; neither are the leaves uniformly contracted at the base, either in young specimens or old. In these particulars both forms exhibit (so far as is known) much the same amount of variation as *C. australis*, *C. banksii*, or *C. pumilio*, and the same remark will apply, although possibly with less force, to the yellow or red colouration of the principal veins, a character upon which stress has been laid by writers.

Cordyline hookeri, n. s.

Stem arboreous, simple or branched, 2–18 feet high, massive. Leaves thick, excessively coriaceous, 2–5 feet long, ensiform, glaucous beneath, usually much contracted immediately above the base, central vein not prominent. Panicle cylindrical, pendulous, 3 feet long or more, with immense bracts at the base 5 feet long, 4–5 inches wide, gradually decreasing in size until towards the middle of the panicle they become shorter than the branches. Branches very numerous, close set, imbricating, simple except at the base of the panicle, jointed with the rhachis. Flowers densely crowded, shortly pedicelled, $\frac{1}{3}$ inch in diameter, bractlets scarcely longer than the pedicel, very white, globose, seeds black, angled.

Habitat—North Island, Ruahine Mountains, Colenso; Mount Egmont, Buchanan and others; Hauraki Gulf, lofty ranges between the Miranda Redoubt and Eastern Wairoa (young plants only), S. P. Smith. I have also been informed that the same plant occurs on high ranges between the Northern Wairoa and Whangarei.

The only flowering example that has yet been available for examination is the fine cultivated specimen in Mr. Owen's grounds at Epsom, which flowered for the first time in November last (1872), when it was six years old. It was at once seen that it differed from the Dusky Bay plant in the small size of the individual flowers, which are not more than $\frac{1}{3}$ inch in diameter; Forster's plant being described as having flowers from $\frac{3}{4}$ to 1 inch in diameter; and in the relative length of the bracteoles, which, in our plant, are scarcely longer than the pedicels. It does not appear, moreover, that Forster's plant possesses the immense bracts of this species, a character too prominent, if present, to have escaped the notice of so good an observer.

The dimensions of Mr. Owen's plant are: height of stem $11\frac{1}{2}$ feet, circumference, at 2 feet from base, 1 foot 8 inches; leaves $4\frac{1}{4}$ feet long, width at base 8 inches, sharply contracted to $4\frac{1}{2}$ inches, and gradually widening to 6 inches just above the middle of the leaf. Four offsets have been given off with leaves 3 feet long, or more. After flowering the stem divided so far as to form two crowns, the younger of which appears to be dying off. In mature leaves the central nerve is not prominent, but in young leaves it is sometimes

of a faint red tinge with yellowish discolorations on each side; lateral veins distinct, but not prominent.

The large panicle was not simply drooping, but pendulous, the rhachis being sharply recurved, so that it grew downwards parallel with the trunk, with which the panicle was in close contact for the greater part of its length. It developed nearly 200 branches, and, on a low computation, must have borne fully 16,000 flowers.

Mr. Colenso has always contended for the specific distinctness of the North Island plant, and in this has been supported by Dr. Hector and Mr. Buchanan, the latter, I believe, being the only botanist who has had an opportunity of examining Forster's *C. indivisa* from Dusky Bay and the present plant from Mount Egmont in a living state, although unfortunately not in a flowering condition.

The New Zealand *Cordylines* comprise several dubious forms, respecting which fuller information is desirable. One of these exhibits a small, arboreous stem 2 inches or more in diameter, 2–5 feet high, narrow drooping leaves 4–5 feet long, and large, sparingly-branched, drooping panicles 5 feet long, with comparatively few flowers. A fine example of this elegant form was formerly to be seen near the Ponsonby Road, Auckland; and I believe a plant found by Mr. Buchanan and Mr. Robert Mair, at Whangarei, to be identical. Its affinities are evidently with *C. pumilio.* The form cultivated by the Upper Wanganui natives*—so far as an opinion can be formed from the foliage of young plants only—is closely related to *C. australis*, but I believe the flowers are unknown. The fine plant found on the Rimutaka Ranges—the "Rimutaka flax" of the settlers—combines to some extent the characters of *C. banksii* and *C. hookeri.* Another singular but elegant form, which appears intermediate between *C. australis* and *C. banksii*, occurs on the Kawau; lastly, a blue-flowered form has been discovered by Mr. Robert Mair at Whangarei, and by Dr. Hector in other localities, but I have been unable to obtain specimens.

C. hookeri is in general cultivation in Europe under the name of *C. indivisa*, but the true *C. indivisa* has not yet been brought under cultivation.

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* Native name, Ti-tawhiti.—Ed.

ART. XLII.—*On the New Zealand Forms of* Cheilanthes.

By T. KIRK, F.L.S.

[*Read before the Auckland Institute, 4th August,* 1873.]

WHILE recently waiting at Lyttelton for the departure of the steamer, in company with Mr. S. C. Farr, I took the opportunity of examining the rocks in the immediate vicinity, when we had the good fortune to find a tuft or two of the typical form of *Cheilanthes tenuifolia*, Swartz, a plant new to me, and offering a marked contrast to *C. sieberi*, Kunze, which is so abundant amongst the scoria in the neighbourhood of Auckland, and in other localities in the North Island. I ascertained that the same plant had been collected by Mr. Potts on another part of Banks Peninsula, and Mr. Farr informed me that he had seen it in other places; but I am not aware of its having been noticed in the colony by other observers since its first discovery by Dr. Lyall, possibly on the spot where it was seen by us, and where it grows associated with the handsome *Senecio saxifragoides.*

The only positive statements I can find of the occurrence of our plant in New Zealand are under the description of the species in "Species Filicum" (Vol. II., p. 82), where it is recorded by Sir William Hooker as having been found on Banks Peninsula by Dr. Lyall; and in "Synopsis Filicum," where it is simply stated to be a native of New Zealand. In the "Flora of New Zealand" Dr. Hooker uses the name *C.* "*tenuifolia,*" Swartz, but remarks, "the figure of *C. sieberi* in 'Species Filicum' resembles the New Zealand plant;" although from his describing the frond as "rarely deltoid," he doubtless had Dr. Lyall's specimens before him. In the Handbook, after describing, at p. 362, the ordinary New Zealand plant as *C. tenuifolia*, var. *sieberi*, Dr. Hooker remarks, at page 748, "This is usually kept as a distinct species—*C. sieberi*, Kunze." It is probably from this cause, coupled with its rarity in the colony, that New Zealand botanists have so completely lost sight of our plant, that no mention of it was made in the Catalogue of Ferns issued by the Geological Survey Department two or three years ago. I may add that I have no knowledge of any specimens in local herbaria, except those to which reference is now made.

C. tenuifolia, Swartz, and *C. sieberi*, Kunze, are considered distinct by Mr. Baker in "Synopsis Filicum," but are certainly of close affinity. Still the difference in the appearance of the two forms, together with the remarkable localization of the first-named, render it desirable that the attention of New Zealand botanists should be drawn to the re-discovery of our plant.

At first sight *C. tenuifolia* is easily recognized by its deltoid fronds and long ascending pinnules; *C. sieberi* by its narrow, almost lanceolate fronds, and

short pinnules. I have drawn up the following diagnosis of each, which differs slightly from those of "Synopsis Filicum."

Cheilanthes tenuifolia, Swartz.

Rhizome covered with silky scales. Stipes tufted, erect, 4″–6″ long, wiry, polished, purple black, slightly fibrillose at base. Frond 6″–8″ long, 3″–4″ broad, deltoid tripinnatifid, glabrous, not coriaceous. Pinnæ 6 to 12, ascending at an acute angle with the main rachis in nearly opposite pairs, or alternate. Pinnules deltoid or oblong, contracted, cut down to the rachis in deltoid or oblong, entire or irregularly-lobed, or crenate, or rounded segments. Rachis narrowly winged above, polished, smooth, glabrous on both surfaces. Sori often continuous, covering the back of the pinnule, and projecting beyond its margin. Involucre crenate or toothed.

Cheilanthes sieberi, Kunze.

Stipes densely tufted, 2″–6″ long, erect and crowded, wiry, polished, brown. Frond 3″–9″ long, $\frac{3}{4}$″–1$\frac{1}{2}$″ broad, narrow-oblong-lanceolate, acuminate, tripinnatifid. Pinnæ in 3 to 15 opposite pairs, lower pairs distant, broadly deltoid, $\frac{3}{4}$″–1″ long. Pinnules pinnate at base, not coriaceous. Segments entire, or lobed, or crenate, often contracted. Sori scattered, rarely continuous, and never projecting beyond the margin of the pinnule. Involucre small, roundish, not apparently toothed.

Art. XLIII.—*On the Spread of* Cassinia leptophylla.

By W. T. L. Travers, F.L.S.

[*Read before the Wellington Philosophical Society, 22nd September*, 1873.]

Most persons who have been in the habit of passing over the hills on the eastern side of Wellington Harbour, or of visiting the Miramar Peninsula, occupied by Mr. Coutts Crawford as a sheep farm, will have noticed the increase, during the last few years, of an indigenous shrub commonly known by its native name as the Taiwhenu, or sea mat-cord, but known to botanists as *Cassinia leptophylla.* They will, probably, also have observed how much this shrub is already interfering with the use of the land referred to for pastoral purposes, occupying, as it does in many places, patches of several acres in extent, and everywhere preventing, by the rapidity of its growth, the attempts of the sheep to make their way through it, or to reach the scanty grass growing about it.

Whilst passing through Queen Charlotte Sound during recent visits to Nelson, I was struck with the very rapid extension of the same plant over all the open parts of the hills, and was led to make enquiries in reference to it, as

it affected the pastoral occupiers, the results of which I will mention in the sequel. I have, moreover, heard that this plant is already interfering greatly with the use of the natural pastures on the east coast of the North Island, more particularly within the Wellington Province; and that sheep-farmers there are looking upon its presence as a very serious and not easily preventible evil. But before mentioning the results of my enquiries in regard to it, I propose to notice a few interesting facts, most of which have come under my own observation, in connection with what Dr. Hooker has termed the "replacement of species," a term used by him to designate the permanent changes which take place in the flora of a new country, as the result of the introduction of competing foreign organisms. The facts which I purpose mentioning, however, though properly associated with such permanent effects, relate only to certain temporary changes in the character of the introduced vegetation, not brought about intentionally or by the direct application of labour.

In former papers, read before this Society, I pointed out that acclimatization (a term, by the way, which I object to as involving a fallacy, and which I think ought to be replaced by 'naturalization'), or the introduction of foreign organisms into a country presenting suitable conditions for their growth and subsistence, is the result of both intentional and unintentional action on the part of man. His intentional action is usually directed to the attainment of beneficial ends, but is constantly accompanied (unavoidably to a certain extent) by mischievous results. Of these latter I may instance the introduction of various forms of *Coccus* and *Aphis;* and of the larvæ of various species of destructive Coleoptera and Diptera, most of which have been brought in Wardian cases; and of the seeds of innumerable weeds, such as those of *Rumex*, *Stellaria*, *Hypochœris*, *Euphorbia*, etc. I also pointed out the results which are usually produced upon the indigenous vegetation in countries previously unoccupied by civilized man, by the introduction of animals and of competing foreign organisms.

It must not, however, be supposed that the struggle thus brought about between the introduced and indigenous forms of life is a mere battle between these two forces, for, in reality, each individual species concerned, whether local or foreign, is fighting "on its own hook," striving against all as against a common enemy, and seeking to secure for itself the greatest share in ultimate occupation. As may be understood, many of the combatants, if not altogether disabled, are seriously enfeebled, whilst the fortunes even of those which are able to show the strongest front are somewhat various. Now, we know that in the hill districts of both islands of New Zealand the chief object of the European settler is to replace the native vegetation by grasses suitable for the maintenance of cattle and sheep, and various processes, more or less direct in their action, are employed in order to attain this end.

Many tracts of such country, as in the Wellington Province for example, are exclusively covered with forest, having a more or less dense undergrowth. Other such tracts are chiefly covered with fern, patches of forest and scrub occupying the gullies and valleys. Others again, chiefly on the eastern sides of both islands, are occupied by native grasses of more or less value for feeding purposes. But whether the indigenous growth consists of forest, scrub, fern, or grass, the great aim of the European is to remove it, and to replace it with a vegetation which experience has taught him to look upon as the most enduring for pasture purposes, even though it may, in some respects, possess a less feeding value than the native growth.

Amongst the ruder processes resorted to is that of periodically burning the indigenous growth, and scattering grass seed upon the bared soil, without any attempt to turn over the surface. This process has produced fair pastures in naturally loose soils, especially in the Provinces of the North Island. In the Wellington Province, however, the young grass is speedily overrun with a growth of *Carduus lanceolatus*, which maintains its position with more or less luxuriance for several years. But it has been found that the temporary inconvenience resulting from the presence of this thistle is more than compensated by the improvement it effects in the soil, and the greater luxuriance of growth in the grass after its disappearance. The grass, however, after having survived this first attack, is usually invaded by a much more powerful foe, the *Hypochœris radicata*, a plant common enough in England, but confined to waste places, and never attaining there the development which it has attained all over New Zealand. I have seen hundreds of acres of land which had been carefully laid down in English grass so completely overrun by this plant that it would have been difficult to discover a blade of grass amongst it, especially in dry weather. In the end, however, the strength of this new enemy becomes exhausted, and the grass again becomes master of the field.

But new foes have lately appeared in Nelson and Canterbury, in the shape of the *Malva sylvestris*, which is most largely developed in Nelson, and the *Achillea millefolium*, which has chosen the pastures of Canterbury for its habitat. I observed lately in Nelson whole paddocks overrun with the mallow, which, unlike its predecessor the hawk-weed, is not eaten by any animal, and threatens seriously to interfere with the production of grass; whilst in Canterbury I noticed the yarrow spreading in the grass fields, and completely displacing the grass wherever it grew.

I might quote many other cases illustrative of the struggle which is going on between various species of introduced organisms for the ultimate occupation of the soil from which the indigenous vegetation has been removed by the more complete systems of culture; but, however interesting these may be, they are far less so than the attempt which *Cassinia leptophylla* is making to

vindicate the title of the native vegetation to the exclusive possession of the open lands which are used as natural pastures, or which have only been subjected to the ruder forms of cultivation. Amongst the causes which are probably leading to the present extension of this plant (independently of the facility which it enjoys, in common with other members of the Compositæ, for the dispersion of its seeds) are the increased production of fertile seeds, owing to the abundance of European bees all over the country; the disturbance of the surface soil by the treading of animals; and possibly the destruction, or at all events a great diminution in numbers, of some form of insect life which formerly fed upon its flower-heads. In connection with the latter suggestion I may mention that it is extremely difficult to obtain mature seeds of many of the indigenous Compositæ. The flower-heads of the varies species of *Celmisia*, which are so abundant in the mountain districts of the South Island, for example, are usually attacked by a small Hemipterous insect, several individuals of which are generally to be found in each head. On one occasion I collected one hundred heads of *Celmisia coriacea*, the seeds of which, to outward appearance, were in good condition, but scarcely one of them contained a single sound seed, out of some eighty or a hundred which had been produced upon it, nearly the whole having been destroyed by the insects in question. But whatever the causes which are leading to the spread of the *Cassinia* may be, the fact and its evil consequences are certain, and it only remains to be considered what is best to be done under the circumstances.

The first and most natural idea which occurs to the mind of the occupier of land thus invaded is, to endeavour to destroy the plant by fire, as is done in the case of other indigenous growths; but this has been found to be impossible, except where its growth is very dense, and not even then until it has attained several years of age. On small holdings, or where grass is specially valuable, it may pay to employ labour to eradicate it with the adze-hoe; but upon large or inferior runs the expense of such a process puts it out of the question. As the result of the enquiries which I made in Queen Charlotte Sound, I am led to believe that in the latter case it is best to let the plant take its course until it attains a growth sufficiently dense to admit of its being burnt. I was informed that it is usually ripe for this operation in about five years, and that after such a burning it does not re-appear, whilst the soil which it occupied has become better fitted for the growth of grass in consequence of its being opened out through the decomposition of the roots. We know that the thistle and the hawk-weed have both died out over immense tracts of country, owing, in all probability, to the exhaustion of some material necessary for their subsistence; and I think it probable that the same cause will operate in the case of the *Cassinia*, even if its destruction be not precipitated by either of the processes above referred to.

IV.—CHEMISTRY.

Art. XLIV.—*Notes upon the Mineral Oils of New Zealand.*

By William Skey, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 16th January,* 1874.]

Abounding, as this colony does, in carbonaceous deposits, mineralized through all the stages of lignite, brown coals, bituminous coals, and anthracite, it is only reasonable to suppose that mineral oils should also occur in it; and indeed oils of this nature have long been known to exist here in small quantity, as films upon the surface of the water of certain springs, or wells sunk to a little depth; but it was only in the year 1866 that the attention of those in a position to give it effect was directed towards ascertaining the precise character of these oils, and the prospects of their occurrence in quantity.*

In that year samples were forwarded to the Colonial Laboratory for analysis, both from the eastern and western sides of the North Island, and the results of their analysis, together with geological reports upon the nature of the country where they were procured, were duly published in the Annual Report for 1866–7, issued by the Geological Survey Department.

Since then further samples have been examined by me from the East Coast, and, though the results obtained upon them have been furnished to the persons by whom they were respectively contributed, and have been besides published in a brief manner in our local papers, still I do not think they have that degree of publicity which the importance of the subject demands for them; nor yet do I think they have that degree of concentration necessary for their easy comprehension by anyone anxious to learn them, as they are interspersed throughout so many publications. In the hope, therefore, of putting all that has been elicited concerning the nature of these oils in a form suitable for those anxious to be informed on this matter, I have prepared this paper.

Before I enter further into this subject I will remind anyone who may need it that these petroleums are simply hydrocarbons, or hydrogen in combination with carbon in different proportions, and every petroleum is a mixture of a great number of such hydrocarbons; and generally, according to the proportion of hydrogen to the carbon of any petroleum, so is its density. As

* N.Z. Gazette, 29th June, 1866. Geol. Rept., 1866–7, p. 8. Col. Mus. and Lab. Repts., 1867, p. 19.

a rule, the more carbonaceous the oil, the greater its specific gravity and the higher its volatilizing point.

Petroleums are, as a rule, mixtures of hydrocarbon oils differing very greatly in density and consequently in volatilizing points, charged more or less with paraffin—a hydrocarbon oil solid at common temperatures; and also with bituminous or pitch matters, to which last they owe their colour; and it has been found that with most or all our petroleums their lightest and their heaviest oils are unfit for the highest use we can put them to—that is, for illuminating purposes; consequently they are separated from the rest by fractional distillation, and the oils of intermediate density thus obtained only require treatment with sulphuric acid and an alkali successively, and to be finally re-distilled, to fit them for their destined use, the acid being used to clear the impurities contained in the oil, and so to convert them into such a form that they can be removed from the oil by water.

It will be observed how very simple the process of refining these oils is, all that is required being steadiness in the distillation, the use of certain chemicals in quantities proportionate to the amount and nature of the impurities present in the oil operated upon, and the proper division of the distillate. I may state that these oils are far easier to purify than those obtained by the destructive distillation of any kind of carbonaceous substance.

Having thus stated briefly the nature of these oils, and the means necessary to fit them for illuminating purposes, I will now proceed with the subject of this paper, in the hope that, by the aid of the foregoing remarks, I may be understood throughout, even by those who may have been hitherto unacquainted with the manufacture in question.

The oils I have had the opportunity of examining up to this time are of three distinct kinds, and from as many distinct localities:

1. The Sugar Loaves, in Taranaki Province.
2. Poverty Bay, on the east coast of the Province of Auckland.
3. Manutahi—Waiapu, East Cape.

1. The first, that from the Sugar Loaves, is a very remarkable oil, its specific gravity being no less that ·960 to ·964 at 60° Fah., water at 1. The heaviest petroleum mentioned by Gesner, ·927, has a specific gravity of about ·930.

All the various samples which have been submitted have the same physical characters, having a dirty green colour by reflected light and being opaque, unless examined in thin films, when it has a deep red colour by transmitted light.

At 60° Fah. it is quite liquid, and though at lower temperatures it has considerable consistency, yet when reduced to 5° Fah. it does not become solid.

It has a mawkish but not unpleasant odour, being very different in this

respect from most rock oils, and is especially free from all traces of sulphuretted hydrogen gas.

Minute flakes of a white substance float in the oil, and are gradually deposited when it is allowed to remain quiet at a low temperature, nearly the whole of this solid substance becoming dissolved when the oil is gently heated.

The temperature at which the oil boils is 340° Fah., and it does not appear to evaporate at ordinary temperature, for when exposed to the air it remains unchanged, neither thickening nor acquiring a skin on the surface.

Its temperature requires to be raised to 260° Fah. before its vapour inflames.

This oil differs from petroleum oils generally in not containing paraffin. In this respect it resembles a so-called surface oil occurring in Santa Barbara County, California. These oils also agree in being of very similar density.

Details of the results of the distillation of a small quantity of this oil have been given in a special report by Dr. Hector, but since then I have had the opportunity given me of operating upon larger samples, and I have thus obtained further results which could not well be observed otherwise.

A large quantity of the oil was distilled very slowly until 82 per cent. of volume of the charge had passed over. The residual matter left in the retort set very hard on cooling to 60° Fah. It had the appearance of pitch, and would have yielded a further quantity of solid and liquid distillates if needed. The density of the several portions of the oil obtained was as follows :—

No.	Volume of Distillate upon Charge.	Specific Gravity.
1	2 per cent.	·880
2	5·5 "	·888
3	5·5 "	·900
4	4 "	·910
5	8 "	·917
6	8 "	·926
7	12 "	·938
8	12 "	·930
9	13 "	·898
10	4 "	·908
11	8 "	·938
	82	

The total amount of oil distilled over was therefore 82 per cent. upon the charge taken, and the amount of residual matter left, 18 per cent. This was a kind of pitch, intensely black, and solidifying to a very hard mass at common temperatures. By destructive distillation it would, of course, yield further oily and solid products.

On an examination of the columns just given, it will be observed that the products of the distillation of this oil do not constantly increase in density as the process of distillation goes on, but that, while they increase in density with

an appearance of uniformity for the first seven distillates, at the 8th, 9th, and 10th, or when about half the oil has been drawn over, these distillates drop very considerably in density, or from ·938 to ·930, ·898, and ·908.

I may state that the temperature of the contents of the retort could not have been lower at this stage than at the one just previous.

We may properly attribute this reversion of density to the splitting up of some oil or oils in the retort into oils lighter and heavier than themselves; and this view is supported by the fact that these two distillates afforded me, to successive fractional distillation, oils very much lighter than any which I could obtain by treating in a similar manner the first distillates of the crude oil. Thus, half an ounce of the lightest oil I obtained from the first four distillates had a specific gravity of ·8574 at 60° Fah., while the same quantity obtained from the ninth and and tenth distillates had a specific gravity of ·7706 at 60° Fah. The latter sample has a much lighter and more agreeable odour than the other.

The heaviest oil I could obtain from this petroleum had a specific gravity of ·964.

Those oils having higher specific gravities than ·950 solidified at 12° Fah.

The last portion of the oil distilled over solidified in the condenser. This portion, on being examined, yielded whitish crystals, which fused at a temperature of about 170° Fah. They are therefore, no doubt, *naphthaline.* I do not think this substance exists in the crude oil; it is most probably a product of some change wrought upon it by the heat employed in the process. Probably the light oil—that with a specific gravity of ·770—and this napthaline are formed simultaneously.

To test the applicability of this oil for illuminating purposes I took a further quantity of it, and retorted over 40 per cent. I then treated the distillate with 3 per cent. of sulphuric acid, shook the mixture well about, washed away the tarry matters resulting, and agitated the oil with 2 per cent. of soda of the strength generally used for purposes of this kind. The oil removed from the soda was then re-distilled until oil equal to 30 per cent. of the quantity originally taken had distilled over. This oil had a specific gravity of ·904. Its colour was a pale yellow. It burns in a kerosene lamp with a dull sluggish flame of small volume, and I question whether it can be made to substitute the kerosene now used here.

The fact, however, is an important one, that by a course of fractional and apparently destructive distillation, the petroleum in part breaks up into a series of oils considerably lighter than any present in the natural oil, and into heavy oils, naphthaline, and tarry matters. By the employment of apparatus appropriate for such a process as this, it is not improbable that a portion of a certain charge of this oil could be so far improved as to be capable of use for

illuminating purposes; but whether this could be attained at a cost sufficiently low to allow a profit on the process is as yet doubtful.

The principal use, however, for which this petroleum appears best suited, is that of a lubricant, and this on account of its low freezing and high volatilizing points, and its exceedingly slight affectibility by air at common temperatures.

2. The next oil I have to describe is that from Poverty Bay, East Coast of Auckland Province.

It is quite different in constitution from the Taranaki oil, being a true paraffin oil, as are most, if not all, of those from the United States of America. It most resembles the Canadian oil.

The following are the characters observed for numerous samples of it:—

Opalescent and thickly interspersed with minute flaky particles of a white colour. By warming the oil gently these particles subside, and the oil manifests the following characters:—Translucent in masses of considerable thickness. Colour red by transmitted, and blackish-green by reflected light. Flows readily, and gives off the usual odour of crude petroleum. Its boiling point at 30 inches barometric pressure varies from 289°–291° Fah. The temperature at which its vapour inflames is from 230° to 233° Fah., and its specific gravity varies from ·864 to ·871 at 60° Fah. It passes into a jelly-like mass at 50° Fah., a circumstance owing to the quantity of paraffin dissolved in the oil.

The petroleum, carefully distilled, afforded the following results:—

No.	Volume of Distillate upon Charge.		Specific Gravity.
1	2·5	colourless	·809
2	16	nearly colourless.	·826
3	16	pale yellow.	·836
4	19	dark yellow.	·850
5	11	dark yellow.	·855
6	8	brown; solid at 40° Fah.	·864
7	21·25	paraffin oil.	
	93·75		
	6·25	—Residue in retort, pitch.	
	100·00		

Nos. 1, 2, 3, 4, and 5 of these distillates were mixed and purified with 2 per cent. of sulphuric acid and 2 per cent. of soda solution successively, then re-distilled.

The first 2 per cent. drawn over had a specific gravity of ·805. This was kept separate from the other, and the distillation continued until the distillates respectively had a specific gravity of ·838 (No. 3), or 36° Baume; this being the density of the lamp oil obtained from the Canadian petroleum, to

which, as I have before observed, this oil approximates most nearly of any of those from America.

The yield of oil of this gravity was 55 per cent. of the original charge by volume. The first portion of this—30 per cent.—was colourless; the remainder had a feeble tinge of yellow, which deepened a few shades in a week.

A portion of this oil was tested for illuminating purposes in an ordinary kerosene lamp, and was found to burn with a voluminous clear white flame, which was maintained very steadily until but little of the oil remained unconsumed in the well of the lamp used.

A further experiment upon this petroleum showed that by three successive distillations, and treatment with acids and alkalies, about 65 per cent. of an oil could be obtained from it, having a specific gravity of ·843, and burning with a good flame in lamps of this kind, although containing paraffin in some quantity. Most, if not all of our kerosenes, however, contain paraffin in greater quantity than the oil in question, so that I should consider the presence of a little paraffin no serious objection to the oil.

These results then show that about 65 per cent. of this oil *may* be obtained sufficiently light for use in our ordinary kerosene lamps. In this 65 per cent. I have included the "feints" in the very lightest oils of this petroleum, and I do not see why I should throw them out, as our kerosenes are charged with oils still lighter than these, and in greater quantity, as I shall presently show. However, from 1 to 1½ per cent. taken off does not affect the value of the oil at all seriously.

I will conclude my note on this oil by stating that the lightest and the heaviest oils I have yet obtained from it are of a specific gravity of ·7289 and ·885 respectively, at 50° Fah.

3. The last of these petroleums is that from Manutahi, on the Waiapu River. The first sample was forwarded to the Colonial Laboratory by Major Ropata.

It is the lightest oil of any I have yet tested, occurring in this country in a native state. The following are its special characters:—Colour pale brown, nearly or quite transparent; does *not* manifest a green-black colour by reflected light. Flows with great freedom; has the odour of kerosene. Specific gravity, ·8294 at 60° Fah. Burns well in a kerosene lamp for some time.

These characters show the oil to be of a very superior class, indeed so very superior that I at first suspected it had been "improved" by some one. However, further operations upon it soon showed that that was not the case. Thus it contains at most but traces of paraffin, as it does not acquire any increased consistency when lowered in temperature to + 8° Fah., while all our kerosenes now in the market solidify at this temperature, and the other

Poverty Bay petroleums at considerably higher temperatures. It is obvious, therefore, that this sample is not a mixture of the two, as naturally suggests itself, but a *bonâ fide* production. I believe it to be the former oil re-distilled, but in a natural way.

The oil, submitted to distillation, afforded the following results :—

40	per cent.	colourless oil at specific gravity	...	...	·800
33	"	pale coloured oil "	...	...	·826
12·5	"	yellow " "	...	...	·840
6·25	"	... ...	...	...	·860
4·25	"	... ...	...	...	·870
96·00	—Total distilled off.				
4·0	—Residue in retort.				
100·00					

The residue is oil saturated with paraffin. It sets at common temperatures.

The only oils containing paraffin are those of specific gravity ·860 and ·870. It will thus be seen that 85·5 per cent. of the distillate is uncontaminated with this substance; so that, allowing $1\frac{1}{2}$ per cent. for light oils, we have 84 per cent. of an oil obtainable from this petroleum fit for use in our kerosene lamps, and this by a single distillation and without subjecting it to the action of any purifying agents.

By two more successive distillations of the first two samples I obtained oil amounting to 66 per cent. upon the crude oil, and having a specific gravity of ·811, or that of common kerosene. This was almost colourless, and had not, I believe, acquired any darker shade since it was distilled. Two per cent. of the lightest oils have been removed from this sample.

The lightest oils I have yet distilled from this petroleum by three successive distillations have a specific gravity of ·778, ·770, and ·754 respectively. The total quantity amounted to 4 per cent. upon the sample taken. The heaviest oil obtained has a specific gravity of ·871; its quantity, 2 per cent. upon oil taken. This is, therefore, certainly a first-class oil.

For purpose of comparison, I now detail the results of my examination of a brand of kerosene much used here—a good kerosene, burning well, and still a safe one. Taking of this oil the same quantity which I did of the two petroleums just described, I obtained these results by its distillation :—

					Specific Gravity.
4	per cent. at	...	...	...	·7202
17	"	...	...	...	·740
19	"	...	...	...	·768
12·5	"	...	...	...	·802
6·25	"	...	...	...	·821
6·25	"	...	...	...	·8264
4	"	...	...	...	·8287
4	"	...	...	...	·829

		Specific Gravity.
4	per cent. at	·830
4	"	·831
6	"	·8319
87	—Oils distilled.	
13	—Residue in retort—petroleum oil, pitch.	
100		

When the residual matters in retort were reduced to 27 per cent. of the charge they set at 60° Fah., and had a specific gravity of ·856, owing to the large quantity of paraffin present. By mixing the first three distillates, and re-distilling them fractionally, I obtained 4 per cent. of an oil having a specific gravity of ·7139. These results show that even a good sample of kerosene may be charged with paraffin and light oils to a very great extent.

The bulk of the oils, however, making up this kerosene are decidedly of low specific gravity, ·832 being about that of the heaviest of them, so that it is seen the petroleum furnishing this kerosene (and I believe all our so-called American kerosenes) is of a different character from that of any yet found in this country. Thus our Poverty Bay petroleums are superior to these in being less charged with light oils, but perhaps a little inferior to them in having the bulk of their component oils of a heavier sort. However, I do not think much of this point, as the Canadian oil appears in good repute and is of precisely similar quality with the Waiapu oil.

Since the above results were obtained I have had a very small sample of an oil submitted to me by Mr. M'Leod, of precisely similar characters with the one furnished by Major Ropata. It is also from about the same locality. Mr. M'Leod describes the oil as having been skimmed from off the surface of the water which had oozed into a hole that had been sunk about 2 feet deep.

Mr. M'Leod affirms that there is a large tract of country about there from which oil can be obtained in this manner. It is therefore, I think, very likely that the oil may be found in quantity when properly worked for. Anyhow, the matter is well worth following up, and I feel anxious that the company now being formed to practically test our eastern districts in this matter may meet with the success it deserves.

ART. XLV.—*Further Report on the Chemistry of* Phormium tenax.* By ARTHUR HERBERT CHURCH, M.A., Oxon, Professor of Chemistry in the Royal Agricultural College at Cirencester, England.—April, 1873.

Communicated by the Hon. the COLONIAL SECRETARY.

[*Read before the Wellington Philosophical Society, 1st September,* 1873.]

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§ 1. PROXIMATE PRINCIPLES OF THE LEAF OF *Phormium tenax.*

IN examining the constituents of the fresh plant, as received from the Royal Gardens at Kew, particular attention was paid to those substances which seemed likely to prove of interest in themselves, or in connection with the preparation of the *Phormium* fibre. The experiments and results given in this section of the report will be found to relate to the gum, wax, sugar, bitter principle, colouring matter, and organic acids of the *Phormium* leaf. A few words, however, may be first given in reference to the total percentage of organic or carbonaceous matters in the leaves employed. These leaves were in perfection—neither decayed and faded on the one hand, nor immature on the other. They gave, on drying at 212° Fah. (100° centigrade), and subsequent burning in the air, the following percentages :—

Moisture	71·6
Organic matter	26·8
Mineral matter	1·6
	100·0

By a reference to my previous report, § 11,† it will be seen that these results are almost identical with those obtained in the analysis of similar leaves in the year 1871.

The next step was to extract, identify, separate, and finally to examine the chief organic constituents, or proximate principles, of the leaf. The use of water and of other solvents, cold or hot, enables us to make an examination of this kind. Cold water extracts from the divided and bruised leaf a good deal of sugar, with traces of albuminoid matters and of saline substances; hot water removes a good deal of gum and starch along with much of the bitter

* App. to Journ. H. of R., 1871, G. No. 4A.

† *loc. cit.*, p. 12.

principle; ether removes oil and fat; and so on with other solvents. I propose to describe the methods used for isolating the several proximate principles of the plant under the respective headings "Gum," "Sugar," etc.

A.—Gum.

It is to be hoped that much of the confusion once existing as to the gum of the *Phormium* has been cleared up in consequence of recent researches. The gummy matter, which is chiefly found on the inner (or proximal) surfaces of the butts of the leaves, presents no remarkable character, and I cannot suggest any use for which it would be likely to prove peculiarly applicable. It presents the following characters:—When partially dried it swells in cold water, and dissolves almost perfectly in hot: the solution forms, on cooling, a somewhat ropy jelly. The gum has a distinct alkaline reaction to test-paper; and when burnt, leaves a white ash, which contains much potash and lime. The gum is not coloured by iodine either before or after treatment with sulphuric acid: this shows that it is distinct both from starch and from cellulose. [A few particles of vegetable tissue often occur in the *Phormium* gum, and these will of course be coloured by iodine if they have previously been treated with sulphuric acid.] A ropy but clear solution of the gum in water was rendered at first milky by the addition of two measures of alcohol; then a coagulum of white filaments separated. This was a precipitate of the unchanged gum, still retaining the mineral matters (potash and lime) belonging to it in the crude state. A solution of the gum is precipitated by basic lead-acetate, but not by the neutral acetate. The gum is transformed very readily into sugar by boiling it with dilute sulphuric acid.

An attempt was made to purify the gum from its alkaline and earthy salts by means of Graham's dialytic process. An aqueous solution of the gum was acidified with dilute acetic acid, and poured into a floating dialyzer of parchment-paper. A certain quantity of saline matter did escape in the course of forty-eight hours into the water employed, but the greater part of the mineral matter of the original gum remained in the solution upon the dialyzer. It should be noted that gum arabic may be almost completely forced from mineral matter by such treatment.

I find that a solution of the *Phormium* gum yields, on evaporation, a residue which may be almost completely re-dissolved by boiling water.

B.—Wax or Fat.

The percentage of fixed fat or wax in the fresh plant of *Phormium* is not large, generally averaging less than 1 per cent. Most of this fat is on the surfaces of the leaf, and may be removed by the action of a caustic alkali of soap, or of a solvent such as ether. It helps to impart the "bloom" to the leaf, and forms a film, or fine coating, which throws off water. To the presence of this wax

on the exterior of the leaf much of the difficulty experienced in bringing various chemicals to act upon the cellular substance of the leaf itself is due; it also retards the commencement of the retting and fermentation processes for the preparation of the fibre. Of course, the removal of this greasy bloom could not be economically effected on a manufacturing scale by means of a solvent like ether, or even by the use of that much cheaper and still more powerful agent, the bisulphide of carbon (CS_2); but it might be worth while to see how far a brief immersion of the leaf in an alkaline or soapy liquor would answer in actual practice. As an alkaline lye might be prepared from the ashes of the rejected parts of the leaves, the cost of such a treatment as that just suggested need not be considerable. Laboratory experiments have shown me that leaves cleansed from the surface-wax by means of a boiling alkaline solution, are far more easily acted upon by the materials used in their subsequent treatment. It may be here remarked that in the treatment of the dried plant with boiling alcohol, a solution of many of the proximate principles of the plant is obtained, and amongst these some of the wax or fat will be found; but, as the solution cools, the greater part of this substance is deposited in granules, which are soluble in ether, and which fuse below the heat of boiling water.

C.—Sugar.

In determining the existence and proportion of sugar in the *Phormium* leaf, two plans were adopted. When an alcoholic extract of the leaves had been prepared, as described further on, under the heading "Bitter Principle," it yielded, after treatment with lead subacetate and separation of the resulting precipitate, a solution which contained certain lead compounds along with the bitter principle, and much sugar. This solution was freed from lead by means of sulphuretted hydrogen (H_2S), and then, after filtration and concentration, gradually deposited a considerable amount of amorphous sugar. This sugar corresponded closely in properties to the sugar of acid fruits, known as *fructose* or *lævulose.* It was soluble in alcohol, and reduced the red oxide of copper from Fehling's sugar test very readily. A rough determination of its amount gave 4·3 per cent. as existing in the fresh leaves. This number is much higher than the estimate recorded by Dr. Hector in 1865 (1 to 1·5 per cent.); but I consider it rather under than beyond the truth. This apparent discrepancy may, however, be capable of ready explanation. The leaves of *Phormium* upon which my experiments were necessarily made, had been grown in a greenhouse at Kew. The plant was a good deal shaded by the crowding of other foliage, and altogether was growing under quite artificial conditions. These conditions may have been, and are likely to have been, peculiarly favourable to the production of sugar.

When an aqueous extract of the plant was prepared, a still higher per-

centage of sugar was deduced from the examination of the matters thus removed from the tissues of the leaves. The analysis of the solution thus prepared led to the following numbers, as representing the proportion of sugar in the leaves of the *Phormium* :—

	Calculated as Cane Sugar.
In the fresh leaves	5·45 per cent.
In the dry leaves	19·20 „

It may be concluded that these numbers are rather too high, owing to the conversion of some of the gum and starch of the plant into sugar by means of the treatment to which the aqueous extract had been submitted. But though $5\frac{1}{2}$ per cent. of sugar is probably an extravagant estimate, I am inclined to think that it is not more than 1 per cent. in excess of the truth; so far, at least, as the richness of English grown leaves is concerned.

D.—The Bitter Principle.

A notion appears to prevail that the bitter principle of the *Phormium tenax* is a coloured substance : this is quite incorrect. Doubtless when an aqueous or alcoholic extract of the leaf is made, the bitter principle, thus dissolved out, is accompanied by colouring matters, but these matters merely accompany the true bitter principle. If reference be made to the report, p. xix., 1871, of the Flax Commissioners,* it will be seen that the bitter principle is therein spoken of as coloured—"purity of colour can only be obtained by thoroughly washing out the *bitter* principle from the plant." Again, in the appendix to the above-named report, at page 84, Capt. Hutton states, "The bitter principle might perhaps be used as a dye or stain for wood," etc. The mixed nature of the substances extracted from the plant by water, and the subsequent changes which some of the substances undergo in the presence of air and moisture, account for the mistake which I have pointed out. As I shall have again to refer to the colouring matters of *Phormium* in the next section, I will now merely describe the method by which the bitter principle was obtained in a state approaching purity.

The selected leaves were cut into small pieces and then carefully dried. About a pound of the dry matter was then exhausted with boiling alcohol. The hot alcoholic extract (or rather extracts) was then filtered, some wax (see § 1 B) being deposited on the filter during the passage of the liquid through it. The filtered liquid was then evaporated, first in a retort, then at 100° centigrade, and finally *in vacuo*. The residue corresponded to 19·6 per cent. of the dried leaves taken. It was, of course, free from starch and gum, but contained many other substances besides the bitter principle. In order to isolate this principle the following plan was adopted :—The last-described residue was boiled in abundance of water, and then the liquor was filtered.

* App. to Journ. H. of R., 1871, G. No. 4.

To the clear filtrate basic lead acetate was added so long as it occasioned a precipitate. [This precipitate, consisting chiefly of the lead-salts of organic acids, will be referred to further on in this section of the report, under the heading F.] This precipitate was then filtered off, and the clear filtrate purified further, as follows :—Excess of hydrosulphuric acid was passed into it, it was filtered, warmed, and finally evaporated *in vacuo*. The syruppy residue of this evaporation consisted mainly of sugar, but contained also a large proportion of the total quantity of the bitter principle present, as well as some acid substances. To separate the bitter principle, the concentrated liquor was shaken up with ether, in which the acids as well as the sugar are almost entirely insoluble. The ethereal solution was then decanted off and evaporated: it left a residue which was slightly yellow in colour and resinous in appearance. On boiling this residue with much water and a little powdered animal charcoal, the greater part of the bitter principle was withdrawn from solution by the charcoal, which latter substance again yielded it up to strong boiling alcohol. Thus extracted, the bitter principle of *Phormium tenax* is colourless, and exhibits but very doubtful traces of crystallization. Its bitter taste is not disagreeable nor persistent. It does not come within the scope of a chemical report to discuss the possible medicinal value of this bitter principle, but it may be assumed that it possesses active properties, and I am inclined to think that these are tonic rather than poisonous.

E.—Colouring Matters.

The chief colouring matter of the *Phormium* leaf is the usual green colouring matter of plants, namely, chlorophyll. This substance is extracted by alcohol from the dry leaves in abundance, but it is left behind in an altered or decomposed state when the alcoholic extract is evaporated, and then boiled out with water. It is not necessary to dwell upon the properties of so universally distributed a substance as chlorophyll, particularly as there seems little or no probability of its being turned to account in the arts. Its interest in connection with the present inquiry appears wholly to lie in the following consideration. In preparing *Phormium* fibre the chlorophyll may give rise to stains or discolourations if it be not rapidly and thoroughly removed in the first processes to which the leaves are submitted; for though chlorophyll may be removed easily from the fresh leaf-cells containing it, yet this colouring matter is susceptible of certain changes, the products of which, having a dull green or brown colour, are not very easily dissolved from the stained fibre. They seem to find their way into the central cavities of the fibres, from which it is difficult to remove them. But the chlorophyll is accompanied by another colouring matter, which appears to give rise to certain reddish-brown stains on the *Phormium* leaf and fibre. I am inclined to think that this colouring

matter originates in a peculiar principle, of an acid character, which not only exists in the healthy and vigorous leaves of this plant, but which may actually be developed by an alteration of one of the constituents of the fibre itself. I refer to the substance mentioned in my former report under the name "pyrocatechin" (see page 18 of that report). A large quantity of this substance, which has the chemical formula $C_6 H_6 O_2$, appears to be formed, as I previously concluded, from the mere heating of the *Phormium* fibre with water to a temperature of 150° centigrade, when about one-fifth of the weight of the dressed fibre taken is dissolved and transformed into soluble matter. My conclusions on this point have been lately confirmed by another chemist, F. Hoppe-Seyler, who has made pyrocatechin by heating pure linen filter-paper to a temperature of 210° centigrade, for four to six hours, with water. But the action on the *Phormium* fibre, though requiring a much lower temperature, is far more extensive than is the case with flax, with hemp, or even with Manilla. We have, therefore, in the natural occurrence of pyrocatechin in the *Phormium* leaf, and in its easy production by the action of heat and moisture upon the very substance of the fibre itself, a mode of accounting for some at all events of the discolourations and alterations to which the *Phormium* fibre is liable under some modes of treatment. For it must be remembered that pyrocatechin gives rise to a variety of colour-reactions under the influence of chemical re-agents, etc. Of this matter I shall, however, speak in the next heading of the present section.

F.—Organic Acids of the Phormium *Leaf.*

In describing the mode adopted of separating the bitter principle of the *Phormium* leaf, I mentioned the lead subacetate precipitate, formed from the extract of the plant, as containing the lead compounds of the organic acids present. When this lead precipitate has been washed with water and decomposed with hydro-sulphuric acid, it yields a mixture of several acid substances. From the small quantity obtained of these bodies, and the difficulty of separating them, I can give but very slight indications as to the acids of the *Phormium* plant. These appear to be oxalic and citric acids in small proportions, and pyrocatechin in greater amount. This latter substance has been already alluded to under the heading E. It has many of the characters of an acid. Its occurrence in the extractive matters of *Phormium tenax* was recognized by—

1. The formation of a precipitate with neutral lead acetate, and the solubility of this precipitate in acetic acid.
2. The volatility and odour of the substance.
3. The darkening of the solution by the addition of lime-water and exposure to the air.

4. The dark green colour produced by the addition of ferric chloride, and the subsequent change of this colour to a red or purplish red by the addition of an alkali.

§ 2.—Mineral Matter or Ash of the Leaf of *Phormium tenax.*

The amount of ash in the whole leaf of this plant was recorded in my last report.* The percentage of ash in the fresh plants corresponds to 1·59 per cent; in the dry plant it is no less that 5·56 per cent. There is, however, according to a recent determination made in my laboratory, rather a higher percentage of ash in the lower part of the leaf than in the whole leaf. A fair sample of the lower part of the leaves—from one-third to one-quarter of their total length—was prepared, and a careful burning gave, of ash, 6·91 per cent. Of this ash the most valuable, but not the most abundant, constituent is probably potash. An estimation of this substance in the ash prepared as above described, showed the presence of 12·45 per cent. of potassium oxide (K_2O), corresponding to 18·28 per cent. of potassium carbonate (K_2CO_3). It may be roughly calculated that 100lbs. of the fresh butts of the *Phormium* leaves would yield, on burning, an amount of ash containing at least one-third of a pound of pearl-ash. This fact may be of some utility in connection with the preparation of the leaf for the after processes by which the fibre is separated; the ash of the rejected parts of the leaves being applicable to the preparation of a lye, by which the valuable parts of the leaf could be partially cleansed.

§ 3.—Experiments with Prepared Fibre.

Most of the experiments now to be detailed are connected with the oiling of the *Phormium* fibre. The samples used were submitted to certain tests so far as regards their hygroscopic condition, ash, and natural grease, with the following results:—

Description of Fibre.	Moisture.	Ash.	Percentages of Volatile Oil.	Fixed Oil.	Total Oil.
A. Native—good	13·74	·74	·29	·20	·49
B. Machine dressed—good ...	13·32	·63	·14	·29	·43
C. Machine dressed—ordinary	12·79	·51	·38	·26	·64
D. Nichol's process ...	14·17	·70	·56	·36	·92

In the following series of experiments, the samples called A, B, and C, in the above table were employed.

Oiling Experiments, Series I.

Oil used, paraffin lubricating or machinery oil, having the specific gravity ·9243. The fibres used were in their ordinary condition as to hygroscopic moisture. They were thoroughly saturated with the oil, and then submitted to pressure and hammering to remove all excess of oil. The following numbers

* App. to Journ. H. of R., 1871, G. No. 4a., p. 12.

represent the final percentages of oil absorbed and retained by the several samples of *Phormium* fibre, two experiments being made in each case, and numerous weighings :—

Absorption of Mineral Oil (Paraffin Oil) by Fibres.

	A. Native—Good.	B. Machine—Good.	C. Machine—Ordinary.
Percentage of oil retained	12·11	19·41	22·25
	13·30	20·66	24·97
Mean	12·70	20·03	23·61

In order to see how far these numbers really represented the percentages of oil retained by the several samples, it was necessary to ascertain whether the absorption of oil had been accompanied by any loss of hygroscopic moisture. The samples used in this series were therefore reweighed and dried till constant in weight *in vacuo* over oil of vitriol. The loss of water they then suffered sufficiently proved that the absorption of the oil had driven out but little, if any, of the natural moisture of the fibres.

	A. Native—Good.	B. Machine—Good.	C. Machine—Ordinary.
Percentage of water lost by oiled fibres *in vacuo.*	10·79	9·52	8·91
	11·63	10·34	9·64
Mean	11·21	9·93	9·30

It thus appears that the fine native dressed fibre absorbs least oil and retains during such absorption the highest percentage of hygroscopic moisture.

In order further to test the accuracy of the determinations of oil retained by the fibres, direct determinations by means of the "ether process" were made. The prepared and oiled samples which had been dried *in vacuo* contained the following amounts of oil in 100 parts :—

	A. Native—Good.	B. Machine—Good.	C. Machine—Ordinary.
Percentage of oil retained by the fibre, but removed by ether	11·00	17·14	20·88
	11·54	18·91	20·26
Mean	11·27	18·03	20·57

These numbers accord as closely as could be expected with those given in the first table, and show that the fine native dressed fibre retains the least oil amongst the samples tried.

Oiling Experiments, Series II.

The oil used was the same as that of Series I., but the fibres were dried at 100° centigrade (212° Fahrenheit) previous to their being soaked in the oil. It was thought that the removal of the hygroscopic moisture from the fibres would increase the quantity of oil absorbed, and render its penetration into the fibres more thorough. This anticipation was not realized, for less oil was absorbed under the single altered condition (of previous drying) of these

experiments. The percentages of oil retained by dry fibre, after pressing and hammering, as in Series I., were as follows :—

	A. Native—Good.	B. Machine—Good.	C. Machine—Ordinary.
Percentage of oil retained by fibres which had been previously dried. ...	8·31	12·34	15·67
	8·19	14·65	15·36
Mean	8·25	13·50	15·52

Thus we learn that dry fibres absorb less oil than those which are naturally moist; and that the fine native fibre retains the same position as to the percentage of oil which it held in the first series of experiments. From other trials I conclude that drying the fibres previous to oiling or tarring them will prevent the sufficient absorption of the liquid used, while submitting the fibres to a moisture-laden atmosphere may prove beneficial, especially if they be subsequently dried—that is, after the treatment with oil, etc.

Oiling Experiments, Series III.

The oil now used was a colza oil, of sp. gr. ·910. The fibres used were from the same samples as before; the operations of pressing and hammering were conducted in the same manner. The experiments, however, were not very successful or uniform in their results; and the inferiority of a vegetable oil for such purposes was shown by the appearance of the samples after treatment. The following results are selected from a large number which were obtained, but which I do not think would be of any service if introduced into this report :—

	A. Native—Good	B. Machine—Good.	C. Machine—Ordinary.
Percentage of oil (colza) retained by moist fibres	13·6	17·0	14·6
Percentage of oil (colza) retained by dried fibres dried at 100° c. ...	13·3	13·9	16·3

Oiling Experiments, Series IV.

An animal oil (sperm oil), having the sp. gr. ·927, was used for these experiments, which were in other respects conducted as before. As in Series III., the previous drying of the fibres made but little difference in the amount of oil retained after pressure and hammering. However, the character of the treated fibres showed a distinct superiority over those dressed with vegetable oil. A few of the results are here given :—

	A. Native—Good.	B. Machine—Good.	C. Machine—Ordinary.
Percentage of oil (sperm) retained by moist fibres	12·8	13·4	13·4
Percentage of oil (sperm) retained by fibres dried at 100° c.	10·8	15·2	14·1

It will be seen that in all the series no appreciable advantage was gained by drying the fibre previous to treating it with oil. When paraffin machinery oil was used, the result was distinctly disadvantageous when dried fibres were employed. It should be added that the fibres which had been oiled after drying re-absorbed a large proportion of their original percentage of moisture on subsequent exposure to the air.

Colouration of Phormium *Fibre.*

Mr. Skey records some experiments of his own upon the presence in *Phormium* fibres of a substance "susceptible of some striking colourific changes." (See Appendix to Commissioners' 1871 Report, p. 92).* The observation is not new, full details concerning this staining of the fibre by the successive application of chlorine and ammonia having been published by M. Vincent in the *Comptes Rendus* of the Paris Academy a quarter of a century ago. (*Comptes Rendus,* xxvi., p. 598, 1848.) M. Vincent, indeed, recommended the following plan for detecting *Phormium* fibre :—Soak the fibre in chlorine water for two or three hours; then wash it with ammonia water; a violet or pink colour will be developed. But when M. Payen, in 1849 (*Comptes Rendus,* xxix., p. 491), submitted this plan for distinguishing *Phormium* from other fibres to further scrutiny, he was unable to regard it as satisfactory if applied to thoroughly bleached and cleaned fibres, though it might serve to distinguish *Phormium* fibre from crude, unbleached, roping fibres of different origin. M. Payen regarded the principle which gave rise to the colour as not essential to the *Phormium* fibre, but merely adherent to it. The experiments of Mr. W. Skey scarcely sanction such a conclusion, but rather point to the intimate union subsisting between this principle and the cellular substance of the fibre. I cannot doubt, from my own experiments on this point, that the "encrusting" matter of the fibre is the true origin of the substance which gives the coloured re-action in question. The following experiments seem conclusive on this point, unless, indeed, they go further, and prove that the pure cellulose of the fibre is itself capable of such a transformation—a position which it would be difficult to accept.

1st. *Experiment on the Pink Colouration of* Phormium *Fibre after Purification.*

One gram of fine native white *Phormium* fibre (No. 1 of old report† was treated with twelve grams of nitric acid of specific gravity 1·10, and 0·8 gram potassium chlorate, for eighteen days, at a temperature of from 12° centigrade to 18° centigrade. At the conclusion of the experiment, and after suitable purification of the residual cellulose, a proportion of that substance amounting to 83·8 per cent. of the original fibre taken remained. This

* App. to Journ. H. of R., 1871, G. No. 4. † *loc. cit.*, G. No. 4A, p. 12.

cellulose did not acquire any colour by treatment with ammonia, but chlorine water followed by ammonia water did stain it pink. When this fibre, so treated (with nitric acid and potassium chlorate), was further acted on by means of water at a temperature of 150° centigrade for four hours, it gave a yellow acid liquid, and lost a considerable portion of its weight. And yet, after this second and most severe purification, the residual cellulose still gave the characteristic pink colour after a few minutes' soaking in chlorine water and the subsequent application of ammonia. It is impossible to regard the substance susceptible of the colour-change as other than a transformation-product of the very substance of the fibre itself.

2nd. *Experiment on the Pink Colouration, etc.*

A similar purified sample of *Phormium* fibre, but in the preparation of which the acid and alkali method had been employed, gave a dark red-brown colouration with chlorine water followed by ammonia.

Miscellaneous Observations on Phormium *Fibre and the Fresh Plant itself.*

Some experiments on the action of an ammoniacal solution of copper upon the constituents of the fibre were made with the hope of gaining some further insight into the cellulosic constituents of *Phormium.* The results were not accordant with each other, nor with the deductions from the results of other methods of analysis. It was found that the above-named re-agent dissolved out only 21 per cent. of cellulose from a fair sample of machine dressed *Phormium* fibre, but that it extracted no less than 40 per cent. of cellulose from a sample of the same fibre which had been treated with nitric acid and potassium chlorate. Thus it appeared that this latter treatment opened up the fibre to the more complete penetration and solvent action of the ammoniacal copper solution. In another experiment the residue of the action of oil of vitriol upon a sample of *Phormium* fibre was submitted to the action of the re-agent for cellulose. In this case the presence of some cellulose was also indicated, although the previous treatment with sulphuric acid (of sp. gr. 1·53) should have removed it altogether.

It is difficult to effect a complete separation of the various soluble constituents of the *Phormium* plant by means of precipitation with basic lead-acetate, as described in § 1 of this report. The following table gives some idea of the partial separations thus effected :—

Lead precipitate contains pyrocatechin and acids, a little bitter principle on agitation with ether.		Filtrate from lead precipitate contains much sugar and much bitter principle on agitation with ether.	
The residue contains the acids.	The ethereal solution contains traces of the bitter principle and resin.	The residue contains the whole of the sugar.	The ethereal solution contains the bitter principle nearly pure.

Appendix to Report.

The following analyses of the seeds and capsules of the *Phormium tenax* were made in 1865 by Dr. Adriani. In the belief that they may prove a useful addition to a report on *Phormium tenax,* I add them here as an Appendix. I have not had the materials for verifying them at my disposal.

Analyses of Phormium tenax.

	Seeds.	Capsules.
Moisture	8·0	10·7 per cent.
Oil	20·1	1·0 ,,
Resin	3·8	2·6 ,,
Mucilage	14·3	24·0 ,,
Albuminoids or flesh-formers ...	18·3	6·9 ,,
Fibre	31·0	47·9 ,,
Ash	4·5	6·9 ,,
	100·0	100·0

V.—GEOLOGY.

Art. XLVI.—*On the Geological Structure of the Thames Gold Fields.* By Capt. F. W. Hutton, F.G.S.

[Read before the Auckland Institute, 9th June, 1873.]

The extraordinary amount of gold that has been obtained from some of the reefs at the Thames gives a great importance to these gold fields, and a correct knowledge of the geological structure of the district cannot fail to be of great interest to science. But at present a considerable difference of opinion on this point exists among geologists, and as it is only by discussion that a more satisfactory state of things can be brought about, no apology is, I think, necessary for bringing the subject before the members of the Auckland Institute.

In order to make clear the points on which different opinions are held, it is necessary, in the first place, to give a short historical summary of our present knowledge of the geology of the district. Professor Hochstetter was the first geologist who visited these gold fields, and he, after a short examination of the country about Coromandel, in 1859, before any auriferous reef had been found, said that "The coast consists of nothing but trachytic breccia and tuff, in the most varying colours, and in the most different states of decomposition, from the hardest rock to a soft clayish mass, and in various places broken through by doleritic and basaltic dykes. Siliceous concretions, in the shape of chalcedony, carnelian, agate, jasper, and the like, are of very frequent occurrence in these tuffs and conglomerates, likewise large blocks of wood silicified and changed into wood opal. By local geologists those trachytic rocks were erroneously taken for granite and porphyry, and, by a gross mistake, the most sanguine hopes were based upon the notion that these siliceous secretions might be auriferous quartz veins. The Coromandel gold originates from quartz reefs of crystalline structure, belonging to a clay-slate palæozoic formation, of which, under the cover of trachytic tuff, and conglomerate, the mountain range of Cape Colville Peninsula consists. The mountains are so densely wooded that it is only here and there in the gorges of the streams that sections of these slates may be examined. In these sections the clay-slates are frequently found to resemble Lydian stone. They are arranged more or less vertically, their irregular upturned edges affording the most convenient and abundant pockets for the detention and storage for the

alluvial gold washed from the higher grounds. * * * On the slope of the hills I saw large blocks of quartz lying, which, from all appearances, originated from reefs or veins that—according to the statement of Mr. Heaphy—protrude on the top of the dividing range in various places, like walls, eight to ten feet high, and ten to twenty feet thick. * * * The Coromandel gold fields—such was my opinion in 1859—bid fair to grow into importance in future years when the auriferous quartz reefs themselves shall have been discovered." ("New Zealand," p. 96, *et seq.*)

In June, 1864, and in February, 1866, Dr. Hector visited Coromandel, and the opinion he then formed of the structure of the country is thus given in his instructions to me in August, 1867 (Geological Report on the Thames Gold Field, by Captain Hutton, September, 1867. Extract from Dr. Hector's instructions, p. 2):—"The range which separates the Thames Valley from the Bay of Plenty I found to consist of a nucleus of aphanite slates, interbedded with green brecciated and greywacke slates, being part of the upper palæozoic series. Flanking and capping this nucleus is a great development of the following members of the tertiary series:—(*a.*) brown coal formation, very local; (*b.*) quartzose gravels, cemented so that they break away in large blocks; (*c.*) Waitemata series (pliocene); (*d.*) trachytic tuff; (*e.*) trachytic breccia. The palæozoic rocks are cut by dykes of trachyte (granite of the miners), which is charged with auriferous and cupreous iron pyrites. They, moreover, contain quartz veins, which are also pyritiferous and auriferous. The older rocks decompose very freely to laterite, and the fissures then contain secondary deposits of silica, manganese, etc., especially when near the supposed trachyte dykes, alongside of which, in some cases, there would seem to have been fissures that were only gradually filled up by deposits from thermal waters, giving rise to the banded, irregular, and crystalline structure of the lodes which is so characteristic of Coromandel. * * * A third manner in which quartz occurs in the district is in the trachyte tufas, but it is then more chalcedonic and crystalline, and associated with jasper and chert, and is non-auriferous, as proved by the numerous trials at Keeven's Point, Coromandel." And further on he instructs me to "search for the grey pyritiferous rock" (*i.e.*, the dykes of trachyte), "in the beds of the streams."

Dr. Hector's opinion, therefore, agreed with that of Dr. Hochstetter, but he pointed out that the gold reefs (some of which had meanwhile been discovered and were then being worked), were not found in the slates, but in the grey pyritiferous rock, which he took to be dykes of trachyte.

Hitherto gold had only been known at Coromandel, but in August, 1867, it was also found near Shortland; and in September of that year I was sent by Dr. Hector to examine the new discoveries, and I then reported that the country was "almost entirely composed of a huge mass of trachyte tufa

resting on palæozoic rocks, and cut by numerous dykes of diorite,* but occasionally of trachyte. This tufa appears as a softish, grey, coarse-grained rock, weathering white, and sometimes much stained with peroxide of iron. Where cut by dykes it is hardened for considerable distances, and much altered in appearance. As might be expected, however, from its origin, it varies a good deal in character, often containing rounded blocks of diorite one or two feet in diameter; indeed, in three or four places it passes into a true conglomerate, while occasionally small angular stones are found in it forming a breccia; these latter, however, are very local. The whole of the rock, including some of the dykes, is much impregnated with iron pyrites." (Geological Report on the Thames Gold Field, 1867.†) I there state that auriferous quartz veins had been found in eight places in the trachyte tufa, and that I considered that "this tufa is probably of tertiary age, and not older than the Waitemata series." In this report, therefore, I agree with Dr. Hector that the gold reefs are situated here, as at Coromandel, in "grey pyritiferous rock," but consider that at Shortland this rock is only a part of the vast overlying accumulations of tertiary trachyte tufa.

In November and December, 1868, I again visited the Shortland and Tapu districts, and in the report I furnished (Second Report on the Thames Gold Fields. Geological Reports, 1868–69, p. 15) I reiterated my former views, adding that the lower part of the tufa formation had been metamorphosed "into a hard, green, pink, or purple felspar-porphyry, or more rarely into a hornblende-porphyry." I also reported that in the Tapu district some of the lodes were in the older slate formation, which is there nearly vertical, but that most of them were in a trachyte tufa and breccia.

In December, 1869, I visited Coromandel for the first time, and reported, in January, 1870 (Geological Reports, 1870–71, p. 2), that by far the larger part of the country, including the central dividing range, was composed of tertiary trachyte rocks, like those at Shortland, lying unconformably on a basement of older slates, and that all the gold mines were situated in the trachyte tufa. Thus considering the trachyte dykes of Dr. Hector as part of the tufa, and as having nothing to do with the palæozoic slates.

Meanwhile, between 1868 and 1870, Dr. Hector had also several times

* This is a mistake, the dykes are of dolerite, melaphyre, and timazite.

† The map accompanying this report was altered without my knowledge, and it now agrees neither with the report nor with my opinion.

[Only the reference to the map was altered without consulting Captain Hutton, as it appeared to be inconsistent with the report as altered by him before it was sent to press. It originally stood thus;—

Tertiary { Alluvium.
Trachytic tufa.
Sandstone.

Palæozoic? Trachytic tufa.—J. Hector.]

visited the Thames gold fields, and, in April, 1870, he made a report (Geological Reports, 1871–72, p. 88) in which he somewhat altered his former views, although still not agreeing with me. After giving Professor Hochstetter's opinion, he says (p. 89) that "the gold is not, however, as he (Professor Hochstetter) supposed, derived only from quartz-veins in clay-slates, for, as Captain Hutton very justly points out in his report on this district, the area of these exposed at the surface is very limited. On the other hand Captain Hutton, in the same report, does not distinguish between the comparatively modern breccias and agglomerates, which he describes as containing blocks of variously-coloured scorias and lavas, and the more ancient formation of green tufaceous sandstone and porphyry, in which most of the auriferous lodes occur." And in the section that accompanies this report he makes his "greenstone tufa" and "greenstone porphyry," as he here calls them, conformable to the clay-slates and dipping with them at a high angle. But speaking of the Tapu district, he says (*l.c.*, p. 98) that here the reefs occur in "the decomposed slates and bands of greenstone porphyry which intersect them with a prevalent north-east strike." It therefore appears that more extended observations led Dr. Hector to abandon the idea that the "grey pyritiferous rock," in which the auriferous veins occur at Coromandel, is a dyke of trachyte, and to suppose now that it is part of a "green tufaceous sandstone and porphyry," belonging to a formation distinct on the one hand from the older slates, and on the other from the newer trachyte tufa; but he still thinks that at Tapu the reefs are in dykes of "greenstone porphyry" intersecting the slates.

The late Mr. E. H. Davis also visited these gold fields in May, 1870, and reported (Geological Reports, 1870–71, p. 56), as far as I can understand him, in favour of two volcanic formations, one of "diorite sandstone," the other of "tufa"; and these are, I presume, meant to be identical with Dr. Hector's "greenstone tufa" and "trachyte tufa" formations respectively. But he describes Tinker's Gully as "a mass of diorite sandstone with dykes of tufa passing through it" (!) (p. 60), from which I infer that he supposed these two "formations" (?) to be interstratified and elevated on edge; and in other places he seems to think that the "tufa" is only the "diorite sandstone" decomposed. But however this may be, he was, at any rate, of opinion (according to Dr. Hector, *l.c.*, p. 98) that "the Tapu district furnishes very conclusive evidence of two distinct and two widely separated volcanic formations."

In April, 1872, I again visited Coromandel, in order to examine some coal seams which had been lately discovered, and which I shall presently describe, and I then saw sufficient evidence to confirm me in the views that I had previously expressed.

I think, therefore, that the following is a fair statement of the present position of the case.

Professor Hochstetter said that there is at Coromandel a tertiary trachytic formation overlying vertical beds of clay-slate and lydian stone of palæozoic age, and he thought that the gold would be found only in the slates and not in the trachytic formation. Dr. Hector also says that there is a trachytic formation overlying slates, but that the gold is principally found in neither one nor the other, but in a distinct volcanic formation which is considerably older than the trachytes, having partaken in the movements and foldings of the clay-slates.

Mr. Davis appears to have agreed with Dr. Hector.

I agree with Professor Hochstetter that there is a tertiary trachytic formation overlying clay-slates, but say that the gold has been almost entirely obtained from the trachytic formation, and not from the slates; and I deny the existence of Dr. Hector's "greenstone tufa" formation as distinct from the tertiary trachytic one.

As it is now an undisputed fact that the principal mines are situated in a felspathic rock, and not in the slates, the question at issue is reduced to this: Is this felspathic rock part of the tertiary trachytic series, or is it part of a distinct formation more closely related in age to the clay-slates than to the trachyte tuffs, which have been deposited unconformably on its upturned edges?

I will, in the first place, examine all the evidence that I can find in Dr. Hector's and Mr. Davis' reports in favour of the distinctness between the "greenstone tufa" and "trachyte tufa" formations, and then I will state the evidence on which I rely for proving that they are one and the same.

1. *Lithological Evidence.*—Mr. Davis, in his report on the Shortland district (*l.c. passim*), seems to lay stress on the great diversity of appearance in the rocks found there, as proving that more than one formation must exist; at the same time he makes no attempt to trace out these different formations. Dr. Hector, also, by calling his two formations "greenstone tufa" and "trachyte tufa" would seem to imply that, besides a stratigraphical break, a difference could also be made out in the chemical composition of his two formations. But to show the extreme difficulty that Dr. Hector and Mr. Davis must find in distinguishing between the rocks of their older and younger formations, I may point out that Dr. Hector, in his instructions to me in 1867, states that Keeven's Point, at Coromandel, is composed of non-auriferous trachyte tufa belonging to the younger formation (*l.c.*, p. 2); while, in his report of April, 1870, he calls it a tufaceous porphyry, originally a clay-stone porphyry (*l.c.*, p. 90), and again (p. 92) a grey tufaceous sandstone "like that at Kapanga and Tokatea," in both cases including it now in his older

formation; while (at page 91) he says that at Driving Creek "no proper volcanic rocks have ever been met with in the underground workings when they have proved auriferous." Again, this "grey tufaceous sandstone" of Tokatea is called by Dr. Hector in another place (p. 96) "greenstone tuff," while Mr. Davis (p. 97) calls the same rock "trachytic tufa." Again, at Tapu, what Dr. Hector calls (p. 98) "greenstone porphyry," Mr. Davis calls (p. 99) "older trachytic breccia." Dr. Hector, also, although he acknowledges (Trans. N.Z. Inst., II., 367) that the bed rock of the auriferous lodes is the same both at Coromandel and the Thames—and therefore, according to him, "greenstone tuff" or "green tufaceous sandstone"—calls (Trans. N.Z. Inst., I., 48) the bed rock from the Golden Crown Claim a "felstone." It seems, therefore, to me that Dr. Hector has entirely failed to distinguish by lithological characters the difference between his two formations; and I may remark that no greenstone tuff, nor any other basic tufaceous rock, has ever yet been brought from the Thames, and that the term "greenstone tuff" is altogether a misnomer. Of course all agglomerates formed by the latest eruptions would be considered by Dr. Hector as belonging to his younger formation, and it is quite true that they never contain gold; but I shall presently show how it is that these superficial accumulations could not be expected to contain gold in any quantity, and that they afford no proof of two formations.

Great stress has also been laid by Dr. Hector on the supposed similarity of the gold-bearing rocks of the Thames with those of Waimungaroa, Batten River, Cape Terawiti (Prog. Report, 1866–67, p. 32), Dun Mountain (Trans. N.Z. Inst., II., p. 365; and III., p. 288), and of Gympie, in Queensland (Trans. N.Z. Inst., II., pp. 366 and 399; also Museum Report, 1870, p. 4). Putting aside the question whether identity of age can in any way be proved by the identity of the rocks from such distant localities,* I must remark that having examined rocks from the Dun Mountain, Cape Terawiti, and Gympie, I can find but a very superficial resemblance between some of them and some of the melaphyres of the Thames, *which occur only in dykes, and never contain gold veins.* The analyses of the rocks from Gympie—which are from the identical specimens that Dr. Hector says he cannot distinguish from Thames rocks—show that there is a wide difference between them, while the analyses of the Dun Mountain rocks (Lab. Report, 1871, p. 17) show a still greater divergence from those of the Thames; the only one that nearly approaches in composition to the Thames auriferous rock being No. 9—"*a fine-grained argillaceous slate,* with slaty cleavage." In fact, the Gympie and Dun Mountain volcanic rocks are true greenstone tuffs, while the Thames rock is a trachyte of a totally different character to the others.

* The Gympie rocks have been shown by Messrs. Daintree and Etheridge to be of Devonian age, while the occurrence of *Inoceramus* in the Dun Mountain shows that those rocks cannot be older than the Lias.

The reduction of the rates of the base to the silica in a heterogeneous group of widely dissimilar rocks, as are those given on page 16 of the same report (Lab. Report, 1871), can have no possible scientific value, but even here, if it proves anything, it proves that the Thames rocks are quite different from those of the Dun Mountain and Gympie, as they contain considerably more silica.

Dr. Hector has remarked (Geological Reports, 1870–71, p. 93) that "the country occupied by the volcanic rocks (at Coromandel) has a very distinct appearance from the central portion of this part of the range, which is composed of the tufaceous and porphyritic sandstones and felspathic slates." In this I quite concur, but it no more proves that the two are distinct formations than does the difference between the central scoria-cone of an active volcano and the lava streams round its base prove that the scoriæ and lava belong to two geological formations; for it is a phenomenon common to all large trachytic districts that the later outbursts are always more basic in character than the earlier ones, and have almost invariably occurred on the flanks of the mountains. We have, in New Zealand, another example of this in the Malvern Hills, in which case the imbedded fossils enable us to prove that the central trachytic mass of Mount Misery belongs to the same formation as the basaltic lava streams of the outskirting Harper Hills.

Both Professor Dana and Mr. Darwin have attempted explanations of these phenomena, but whether their explanations be true or not the fact still remains that large trachytic ranges almost always have a centre of solid felspar rock, and basaltic lavas with scoriaceous agglomerates on their flanks.

2. *Mineralogical Evidence.*—Dr. Hector has dwelt upon the fact that gold is found in some creeks and not in others; but this, by itself, proves nothing, for not only do all metals occur locally, but gold could not be expected to occur in quantity in those superficial portions of the formation which both Dr. Hector and myself call trachytic agglomerates, for the heat in these portions could not have been sufficiently long continued for the formation of metallic veins, and these rocks are generally so porous that the percolating water would not be compelled to keep in distinct channels.

Jasper and chalcedony are said by Dr. Hector (Report on Thames Gold Fields, p. 2), to be characteristic of the younger formation, but they are both found abundantly at Tapu in Dr. Hector's "greenstone porphyry" formation, and occur also at several places in the Shortland district, as for instance the Karaka Creek.

3. *Stratigraphical Evidence.*—Dr. Hector asserts that his older auriferous formation is only found in narrow belts. He says (Geological Reports, 1870–71, p. 92) that "the shafts and drives on the Tokatea Hill, and also a few of the road cuttings which penetrate the hard rock, show it to be the same

grey tufaceous sandstone, full of mundic, as at Keeven's Point and Kapanga, thus proving this rock to extend in a narrow belt from the sea level to 1,600 feet altitude." I do not see how finding a rock at three different places in a line, and at very different altitudes, can prove that it runs in a narrow belt. It seems to me that the absence of the rock on either side of the belt should be first proved; but I have myself traced this rock for several miles in a direction nearly at right angles to the line indicated by Dr. Hector, and it must be remembered that if the gold should be found to run only in a narrow belt it would by no means imply that the bed-rock did the same; for the distribution of a rock is one thing, and the distribution of gold in that rock is quite another thing. He also says (*l.c.*, p. 92) that "the auriferous reefs are generally in the decomposed rock, and, as at Shortland, have a general direction parallel with the boundaries of the formation, or N. 40° E." But in his map of the Coromandel district he shows his "greenstone tufa" formation running in a nearly north and south direction, and without a single boundary approaching to a N. 40° E. direction. As Dr. Hector has not attempted to map his formations at Shortland, I cannot tell where he supposes the boundaries to lie in that district.

At Tapu, he says (*l.c.*, p. 98) that "the reefs are in bands of greenstone porphyry, which intersect the slates with a prevalent north-east strike." But most of the claims (except those in the slates) are situated in a brecciated rock, which is certainly not intrusive, and could not intersect slates; neither can it be interbedded with them, for the slates here are nearly vertical, and strike east and west. As Dr. Hector has not mapped any of these bands I do not like to speak positively on the subject, but their occurrence in the way that he describes them appears to me to involve a physical impossibility, and, although I made a careful survey of the district, I saw nothing that would lead me to adopt his opinion.

Mr. Davis asserts (*l.c.*, p. 99) that south of Hastings the older volcanic formation strikes north and south, while the more recent tufas are nearly horizontal; but, from a personal inspection of the locality, I am convinced that Mr. Davis mistook jointing for bedding, there being no planes of stratification visible, while his more recent tufa is but the older one decomposed. I made the same mistake myself in my first report on the Thames. Mr. Davis also appears to think that, as a tufaceous breccia is found at the Thames enclosing fragments of tuff or breccia, it necessarily proves two distinct formations. But this is by no means the case, for it is a common phenomenon in all submarine volcanic districts. When an eruption is over, the vent fills up and consolidates, and a subsequent eruption breaks this up into fragments and scatters them around. An example of this may be seen in the Auckland Domain, in a cutting through basaltic tuff of newer pliocene or pleistocene age.

Mr. Davis has brought forward two cases of what he supposes to be unconformity between the two formations. One of these is at Omaru Bay, near Coromandel (*l.c.*, p. 97), and the other at Tapu. In both cases a brown tufa or breccia is supposed to lie on a water-worn surface of blue tufa or breccia respectively. With the example at Tapu I am quite familiar; the one at Omaru I have not seen, but my acquaintance with these rocks in other districts leaves no doubt on my mind that the appearance at Omaru is owing to the same cause as the one at Tapu, viz., the decomposition of the upper parts of the beds, a distinct and undulating line often being seen between the decomposed and undecomposed portions of the same rock.

Dr. Hector also mentions what he considers a case of unconformity in the Ohinemuri district. He says (Geological Reports, 1870–71, p. 102) "the sudden alteration in the form of the hills, and the marked change in the mineral composition of the rock, *and other circumstances*, indicate that *b* is unconformably superimposed on *d*, and that the two formations are distinct." On this I would remark that "the alteration in the form of the hills" is probably caused by the "marked change in the mineral composition of the rock," so that the evidence of unconformity is simply the alteration in the mineral composition of the rock "and other circumstances" which are not specified, and I submit that no geologist would consider this unconformity as proved. But apart from this, unconformity among volcanic rocks can by no means be taken as a proof of two formations, for the products of a volcanic eruption generally lie more or less unconformably on those of the last. I think, therefore, that the evidence adduced in favour of two distinct volcanic formations at the Thames completely breaks down on every point.

Having at last, "Deo juvante," finished my criticisms, I now enter on the more pleasing task of giving the evidence on which I rely for proving that Dr. Hector's "greenstone tufa" formation is simply the older and central portion of the "trachytic tufa" formation, of which the coast accumulations of scoriaceous agglomerates are but the last dying efforts. I ought, however, first to define that I mean by a volcanic formation, or period, the whole length of time from the first volcanic outbreaks in a district to their final extinction, provided that the series of outbursts are not interrupted by a period of repose so great in extent as to be comparable in duration with a geological formation or period.

1. *Lithological Evidence.*—The rocks at the Thames are, as I have already said, very variable in appearance, not more so, however, than is usual in trachytic districts. The chemical composition also remains essentially the same in all the varieties, and corresponds with the same class of trachytic rocks in other parts of the world, such as Hungary, Styria, Teneriffe, the Siebengebirge Mountains, etc., as the following table will show:—

	A			B	C	D	E	F
	Max.	Min.	Mean					
Silica	64·	50·	56·5	68·38	66·39	62·83	57·17	53·85
Alumina	24·	13·	17·86	13·92	17·74	21·25	16·9	17·95
Oxide of iron ...	13·	2·	9·10	2·8	4·97	4·11	8·5	6·94
Lime	10·	·6	3·77	·84	·53	·72	6·3	8·33
Magnesia... ...	3·6	·6	1·49	2·20	·47	·42	1·9	6·47
Alkalies	6·	2·4	3·76	7·53	4·99	6·37	4·9	3·25
Water	7·(?)	3·44	5·63	4·64	4·89	4·15	3·38	2·55
Specific gravity ...	2·68	2·29	2·45	2·57			2·64	

A Bed-rock of auriferous veins at the Thames and Coromandel. The mean is from six analyses, which are all that are published.

B Trachyte porphyry lava from Monte Guardia, Lipari. Resembles a compact clay-stone, and often contains imbedded fragments of augite rock (Bischof).

C Trachytic conglomerate of the Ofenkuhlen. Homogeneous, white, and thinly stratified (Bischof).

D The same (Bischof).

E Trachyte from Gleichenberg, Styria. Resembles felstone porphyry, compact, and of a greyish-green colour with a few felspar crystals (Bischof).

F Trachyte. Hrad Mountain, Hungary. Matrix fine-grained, grey, rather porous, and very hard. There are a few very small laminæ of felspar and hornblende in it (Bischof).

The chemical composition of these rocks, it will be noticed, is similar; E especially is remarkably like the Thames rock, both chemically and physically. They are all called trachytes, and are all characterized by containing a large amount of water of constitution; at the same time they differ among one another quite as much as do the most different varieties of the tuff rocks from the Thames that have, as yet, been analyzed. Of course the dyke rocks must not be compared with these; they are more basic, and do not contain auriferous veins at the Thames. Hitherto I have called the bed-rock at the Thames a tuff, or tufa, and in this I have been followed by Dr. Hector and Mr. Davis; but a recent examination of the Malvern Hills has led me to doubt the propriety of the name. This rock has undoubtedly not been ejected in the fragmental state that is implied by the word "tufa," neither has it flowed over as a lava in the ordinary sense of the term, but appears to have welled up in a manner different from anything that has been observed on the surface of the earth. On the whole I believe it to be more nearly allied to a lava than to a tuff, and I consequently prefer the word trachyte to that of trachyte tufa.

2. *Stratigraphical Evidence.*—The different varieties of rock pass gradually one into the other, no line of division extending beyond a few yards having been found, and no sequence of the different varieties can be traced, as can always be done among stratified rocks. I think, therefore, that all varieties of trachyte, porphyry, and breccia must be considered as belonging to one formation. Now this formation is spread over the greater part of the peninsula, and attains a height of 2,600 feet above the sea; and a closer examination of the district shows that the porphyries and other more metamorphosed varieties of the trachyte are found only towards its lower part, and do not extend up into the hills, as may be easily seen by examining the mines at various levels in the Karaka and Tararu Creeks, where metamorphism has been most active. This cannot be due to decomposition of the upper portions, for near the base of the formation the rocks are quite hard in places where they have been exposed to the atmosphere for a long time, while higher up long drives into the hills show that the rock there has never been changed into a porphyry, for it contains no crystals nor crystal cavities. It is impossible to account for this fact on the supposition that the porphyries are older rocks tilted up, but it follows naturally from the supposition that the whole mass is of volcanic formation, which was ejected in a heated state; for then the lower portions must have retained their heat longer than the upper, and, as the felspathic nature of the rock renders it very liable to metamorphism, there is nothing extraordinary in finding the lower parts changed into a porphyry.

Those districts which are most metamorphosed are also most brecciated, such as the Hape, Karaka, and Tararu Creeks, the beach north of the Opitomoko, and the country about Tapu. This probably shows that the more metamorphosed districts were nearer to the volcanic vents. The absence of scoriæ is no argument against this view, for, as I have already said, the trachyte is more nearly allied to lava than to tuff, and it was certainly ejected below the sea, while scoriæ can only be formed in the air. I have already mentioned the great extent of country which this formation covers. This alone proves either that it is nearly horizontal, or that it is thrown into undulating curves. But the mines at the Thames have shown that it is crossed in *all directions by nearly vertical dykes*, which have no particular direction of dip in different localities, which would certainly be the case if the formation was thrown into undulating curves. At Coromandel seams of coal have been found at Sykes Gully, in the Kapanga township, and in the Hinau Creek, a small tributary of the Matawai.* In the first case the coal dips N.N.W. 15°, and in the second it is almost horizontal. In both places it is overlaid by

* Both these beds of coal occur in the district marked as "greenstone tufa formation" in Dr. Hector's map of Coromandel. (Geo. Rep., 1870–71, p. 98.)

trachyte and trachytic agglomerate, which, in Sykes Creek, contains gold. At this place the coal is underlaid by a grey fire-clay, which rests unconformably on slates, while at the Hinau the coal rests upon trachytic agglomerate, which again rests unconformably on slates. The coals from the two places are similar to one another (for analysis see Geological Reports, 1870–71, p. 175). These facts therefore prove that the trachyte formation lies in a nearly horizontal position, or in the position in which it was originally formed; and, as the underlying slate rocks are always highly inclined, it necessarily follows that the trachytic formation lies unconformably on their upturned edges, and this can be distinctly seen at the point north of Tararu, at Tapu Creek, on the coast between the Mata and the Waikawhau, and at the Waiau, Coromandel.

I have now, I think, proved—

1. That no line of separation can be drawn showing the existence of two volcanic formations separated from each other by a long period of time.

2. That the rock in which the auriferous veins are found does not run in nearly vertical bands, but is lying in its original (nearly horizontal) position.

3. That all the phenomena are consistent with the idea that the formation is one, the older portions forming the centre, and the younger the outskirts.

With regard to the age of the older part of the formation, we have no palæontological evidence, but there appears to be no reason for separating it from the trachytes of the Great Barrier to the north, nor those of the Aroha to the south, which are undoubtedly tertiary, as they are connected with still existing craters. We have also no evidence of the occurrence of any volcanic rocks in this part of New Zealand before the deposition of the Waitemata series, which I consider to belong to the oligocene period. The rocks themselves, both the trachytes and the dykes, closely resemble those of the gold-bearing rocks of Hungary, which have been lately proved by the Austrian survey to belong to the miocene period, as was indeed long ago pointed out by Professor v. Pettko (Q.J.G.S., 1848, ap. 61); and although I cannot attach so much importance to the nature of volcanic rocks in determining their age as is done by most German geologists, still in this case the two kinds of evidence point the same way. I therefore think that the gold-bearing trachytes of the Thames belong to the oligocene period, a period when volcanic action was active not only near Auckland, but also in the South Island and in the Chatham Islands.

Art. XLVII.—*On the Formation of Mountains; a Reply to the Rev. O. Fisher.* By Capt. F. W. Hutton, F.G.S.

[*Read before the Wellington Philosophical Society, 1st September,* 1873.]

Having, at the last meeting, been requested by the President to lay before the Society my reply to the Rev. O. Fisher's critique, which appeared in the June number of the Geological Magazine, on my previous lecture on the formation of mountains,* I have now the honour to do so.

I have, in the first place, to thank Mr. Fisher for recalculating—more correctly, no doubt, than I have done—my table of the altitude of domes, and also for explaining several points which I had not clearly conceived before. Nevertheless, I think that I shall be able to show that his arguments against the theory that I have advocated are not well founded.

For the sake of conciseness I will, in what follows, call the theory that Mr. Fisher advocates the "contraction theory," meaning thereby the theory of the formation of mountains by the secular cooling and contraction of the earth; while I will call the theory that I advocate the "deposition theory," by which I mean the theory of the formation of mountains by the removal of matter from one portion of the earth and its deposition on another portion. In my lecture I called this latter the "Herschel-Babbage" theory, but I have since ascertained that Mr. Scrope was the first to suggest it, and it has therefore no right to the name that I applied to it.

(*a*.) The first argument that Mr. Fisher adduces against the deposition theory is, that any lateral pressure of expansion must be taken as strictly horizontal, and could not cause an upward rising. But the pressure relied on by Mr. Fisher to produce mountains is just as horizontal as the pressure produced by expansion, and if a cube foot of rock would be simply compressed by the horizontal pressure caused by expansion, why should not the effect be the same if the horizontal pressure was produced by the contraction of the nucleus? Practically we know that a perfectly horizontal sheet of dry paper stretched on a board will wrinkle when its dimensions are increased by damping; and the crust of the earth must do the same unless it crushes. From observation we know that anticlinal curves have been formed, and that the crust therefore does not always crush up.

Mr. Fisher also says that "we have no right to consider the crust rigid when regarded in proportions of sufficient dimensions to admit of these lateral pressures being otherwise than sensibly in the same straight line, but in opposite directions." In his first paper, however, on the formation of mountains (Trans. Camb. Phil. Soc., 1869), he not only says that the portion of the

* See Trans. N.Z. Inst., Vol. V., App., p. xxv.

"rigid" spherical shell that he is examining is kept in equilibrium by its attraction towards the centre (*i.e.*, its weight), and by the pressures tangential to great circles round the circumference of the shell (*i.e.*, the lateral thrust of the arch or dome), but he calculates the amount of the latter, and shows that it is independent of the size of the shell, except so far as the size alters the weight; and I really fail to see the difference between this and stating, as I did, that each portion of the rigid crust is partly supported by the lateral thrust of the arch.

(*b.*) Mr. Fisher explains very clearly that the interior could not rise higher than the surface by its own pressure, but it does not necessarily follow from this that "any abnormal elevation of a portion of such crust must be owing to lateral pressure," because it might be owing to an increased upward pressure caused by the sinking of some adjoining area. This shows that the anticlinals could seldom attain the full amount of elevation shown in my table, for the abutments must sink; but the table shows an ample margin for such depressions.

(*c.*) Mr. Fisher says that the rocks would crush, and not rise up in anticlinals. But in order to crush there must be some space to crush into, and, by the deposition theory, it is the *lower* beds that are undergoing compression, while the upper are not; and, in order to relieve the compression, the upper beds must be forced up, either by fractures being formed and certain parts only raised, or else altogether, into one or more dome-shaped elevations. The last requires much the least work, and is therefore the way in which the pressure would be relieved. On the other hand, by the contraction theory, the *upper* beds are subject to the greatest compression, and, having no weight upon them, they would undoubtedly crush.

(*d.*) Mr. Fisher says that the specific gravity of the disturbed rocks ought to be less than it was before. This would be the case with the rocks causing the movement only while they were heated, and even then the difference would be too small to detect. When the rocks cooled they would go back to their original length by faulting, and the specific gravity would be the same as before.

These are all the arguments that Mr. Fisher can find against the deposition theory, and they virtually resolve themselves into this question: When rocks are expanded by heat do they, or do they not, crush up? The best answer is found by examining the rocks themselves, where we find that rocks which have been deeply buried, and which therefore *must* have been considerably heated, are not crushed but thrown into anticlinal and synclinal curves; and that *the deeper they have been buried the more they have been folded*, except when the burying occurred so long ago that the former more rapid conduction of heat outwards appreciably affected the result.

Mr. Fisher then proceeds to attack my illustration of the theory from the Weald. But the Weald was not "adduced to give verisimilitude to this theory" as Mr. Fisher supposes, neither did I "pretend" to any precise measurements, as any unprejudiced reader will see, but it was given as an example of the way in which the theory might be tested in the field.

I have not access to any precise *data* as to the thickness of the beds, or the height or breadth of the anticlinal, and exact measurements would have been quite useless unless we also knew exactly the rate of expansion. In geological enquiries mathematical investigation can only be used as a check to our speculations, and as giving us a limit beyond which we cannot go. The average thickness of the cretaceous rocks was taken from Jukes' "Manual" (1862, p. 602), and the height of the hills in the Weald from Lyell's "Elements of Geology." If the true thickness was under-estimated, by so much would my example tell against myself. The rocks below the wealden were not taken into consideration because they were the old surface, and had nothing to do with raising the temperature. Neither did I ever regard the wealden area as an isolated dome-shaped elevation, but the other elevated areas have, by the deposition theory, nothing to do with the amount of elevation of the Weald.

With regard to the latter part of the paragraph, it is, I believe, uncertain whether the tertiary rocks ever extended over the chalk or not; at any rate the fresh-water beds, as well as the vegetable remains of the London clay, show that land was then in the neighbourhood, which land must have been elevated since the deposition of the chalk in a deep sea. The depression succeeding the Woolwich beds no doubt took place after the dome of the Weald was formed; but I must leave these questions to be worked out by those geologists who have an intimate local knowledge of the district.

Hitherto I have confined myself to urging the claims of the deposition theory, but as Mr. Fisher says that he has "not had the good fortune to hear of the many arguments which have been urged against" the theory that he advocates, I will briefly state the reasons that have led me to reject the contraction theory as giving a sufficient explanation of the formation of mountains. I do so with the less reluctance, because nearly all rival theories in natural science must ultimately be weighed by the balance of probabilities, and it is therefore just as important to argue against a theory as to argue in favour of it. (Appendix.)

My reasons for rejecting the contraction theory are:—1. Contraction of the earth could not produce any tangential pressures except in solid rock, so that the lateral compression must be confined to the rigid crust; consequently the more rapid contraction of the lower beds could only cause the upper beds to rise into anticlinals by one solid portion slipping horizontally over another

solid portion. This is mechanically impossible, because the resistance to sheering would be far greater than the resistance to crushing when the area exposed to the compression was small compared to the area of the surface over which sliding has to take place. Neither in nature do we find any of these horizontal faults, which ought to be numerous and of considerable amount if the contraction theory be true. In the example, for instance, given by Mr. Fisher (Trans. Cam. Phil. Soc., 1869, p. 15, fig. 3), the central portion must have been faulted over the lower contracting beds for nearly half a mile. In this way utter confusion would reign in stratigraphical geology—palæozoic rocks would have slipped for miles over mesozoic rocks, granite over stratified beds, etc. It is quite certain that nothing of the kind has taken place in any portion of the earth's crust that has yet been examined. It is, however, accepted as probable by Professor Shaler (Geological Mag., V., p. 511); and Mr. Fisher also, when advocating the contraction theory, appears to see no difficulty in the thrust being extended through 50 miles of rock, although, when criticising the deposition theory, he says that the thrust can only be supposed to extend to an infinitesimal distance.

2. From the absence of any weight on the compressed rocks; from the impossibility of one part slipping horizontally over another; and from the absence of any support if any part should rise up into an anticlinal, we may, I think, confidently assert that the crust of the earth would simply crush up from the effect of contraction, and would rise uniformly over the whole surface. Mr. Fisher's formula, therefore, for the elevation should be $h = k\,e$ instead of $h = 2\,k\,m\,e$.

3. If, however, it be granted—for the sake of argument—that the strata did not crush, but rose up on the lines of least resistance, it seems to me that these lines would take radiating directions from an area of depression; and that when these lines were once established, whatever their direction might be, elevation should be continuous on them. The theory, therefore, by itself appears to offer no explanation of oscillations in level. Professor Dana, however, seems to see no difficulty from this cause (Geology, 1863, p. 718, etc.), but he gives no explanation of it.

4. The same being granted as before: as the upper beds must undergo the greatest compression, the foldings would commence at the surface and would be propagated downwards in decreasing amount, and, as all sedimentary beds must once have occupied the surface, it follows that *all strata should be more or less folded in proportion to their age*, because the older they are the larger must have been the proportional area originally occupied by each. But we know that there are large districts in Russia and North America formed of undisturbed palæozoic rocks, while in Switzerland and Northern India tertiary beds are highly contorted.

5. The theory also entirely fails to account for strata being elevated without disturbance, unless we suppose such an amount of horizontal slipping of one bed over another as is manifestly impossible.

6. If, however, as appears to me certain, the rocks must crush and rise tolerably uniformly, it is evident that the theory is quite inadequate to account for mountains; for, the contraction being universal, and the sea occupying the outer surface of the earth, *the sea would rise more than the land*, and the result would be that after the contraction the sea would stand higher above the land than it did before. In other words, the land would be said to have been depressed instead of having been elevated. If, therefore, we consider the earth when the crust was first formed, and it was surrounded by a universal ocean, we see that no land could rise above the water from contraction, but that, on the contrary, the ocean would gradually deepen. It was these considerations that led me to suppose that the first deposits were of organic origin, and that it was these deposits that first raised land above the water.

7. Mr. Fisher assumes, without giving any reasons, that since the date of the present surface features of the earth, a shell, 500 miles in thickness, has contracted as much as rock would do in passing from a fused to a devitrified state. But is this a reasonable assumption? I think not. It is certainly quite as reasonable to suppose, with Sir W. Thomson, that it is 100 millions of years since the crust of the earth cooled; and if we suppose that the oldest Laurentian rocks date from this period (which is the most favourable supposition that can be made for Mr. Fisher), then the Cambrian period will probably date about 50 millions of years ago; and, taking the thickness of formations as our guide, it is as reasonable a supposition as can be made that of the other 50 millions of years 39 were occupied by the rest of the palæozoic era, 9 by the mesozoic era, and 2 by the cainozoic era. So that, if we suppose the present features of the earth to have originated in the triassic period, it follows that 11 millions of years is the oldest date than can be assigned to any of them. This, by Fourrier's calculations of the rate of cooling of the earth—allowing for the slight increase of radiation in former times—is only sufficient to allow it to decrease 4° F. in temperature; and if we suppose that the whole of this heat was abstracted from the shell 500 miles in thickness underlying the crust, its temperature would be reduced by only 12° F., which is not nearly enough to give the amount of contraction supposed by Mr. Fisher.

8. We can look at this question in another way. If the surface of the earth has contracted, as Mr. Fisher supposes, one mile in a hundred since the present surface features originated, and the circumference is now 24,856 miles, it must at the time supposed have been 25,104 miles in circumference, and the radius, which is now 3,956 miles, must then have been 3,995 miles, so that it must have shrunk 39 miles. This in 11 millions of years would be

11·9 yards in 2,000 years, the time during which we have astronomical observations, or 1 inch in $4\frac{1}{2}$ years.

9. If, however, for the sake of argument, we allow Mr. Fisher all he asks, namely, that a mountain half a mile high might be formed on every 100 miles since the present surface features originated, we then find that, taking the date as before, Mr. Fisher's mountain has taken 11 millions of years to rise 2,640 feet, or it has risen only 1 foot in 4,166 years, which is slower than the ascertained rate of denudation.

Mr. Fisher, therefore, is in this dilemma: either the contraction of the earth's radius has been so rapid that astronomers ought to have detected it; or else elevation has been so slow that no land could rise above the sea level.

10. Another important objection to the contraction theory, is that mountains have always been formed in those places where deposits have been heaviest; while, by that theory, those areas should never rise at all. Mr. Fisher says that "the local pressure caused by a fresh deposit * * will originate a line of elevation along its shore line or boundary," and again, "the thickness of the rigid crust being increased by the new deposit, it would offer an impediment to the elevation of ridges beneath it, and throw the whole disturbance into the region just outside its boundary." This is exactly opposite to what we see in nature.

11. In my previous papers on this subject I have pointed out that mountains are formed on two different plans, the one being associated with volcanic rocks, the other with the crystalline schists; but the contraction theory supposes that all mountain chains are identically formed.

12. My last objection is, that this theory makes no provision for tension in rocks—everything is done by compression; while faults prove tension just as surely as contortions prove compression.

I am therefore of opinion that the effect on the crust caused by contraction has been very small, and that it has been totally obliterated by the much larger effects caused by deposition.

In conclusion, I wish to explain that I do not consider it necessary that the whole of an area must have been under water in order that it may be raised by the deposition of limestone; but that, owing to the lateral conduction of heat, one or more mountain ranges might project out of it as islands. Indeed, I believe that all high mountain ranges are the result of several subsidences and elevations, during which they may never have totally disappeared under the ocean.

Appendix.

Extract from the Rev. O. Fisher's Paper "On the Elevation of Mountains by Lateral Pressure." (Trans. Cambridge Philosophical Society, XI., 1869.)

Let us call t the thickness of the crust, which has been thrown into corrugations by the contraction of the subjacent stratum; and, for the sake of illustration, let us suppose one chain of mountains to be formed across every hundred miles of a great circle.

Let A B D C, fig. 1, be a vertical section of such a portion of the crust before the contraction of the stratum below it.

$$AB = 101 \text{ miles.} \quad AC = t. \quad EB = 1 \text{ mile.}$$

Then, owing to the contraction of the stratum below, A B D C will assume some such form as A M B D C, fig. 2, or fig. 3, where A B = 100 miles, and it is clear that the section of the elevated mass M being due to the shortening of the base of the rectangle A D by one mile (if we neglect compression), must be equal to the rectangle E D, *i.e.*, to t square miles.

If then, as supposed, the crust be 25 miles thick, and, for simplicity's sake, we take an isosceles triangle for the profile of the upraised mountain mass, we shall get an isosceles triangle of 25 square miles on a base of 100 miles, which would give a range of mountains half a mile high. If only 50 miles out of the 100 were disturbed, as in fig. 3, the range would be a mile high, and so on. Such ratios would be rather greater than occur in nature, even allowing for subsequent denudation, so that the theory seems to be at any rate not deficient in its capability for producing the results attributed to it.

Art. XLVIII.—*Port Nicholson an Ancient Fresh-water Lake.*

By J. C. Crawford, F.G.S.

[*Read before the Wellington Philosophical Society, 18th August,* 1873.]

A remark and a question by Dr. Hector have led to the subject of the following observations. The remark was that the peculiar denudation of the Miramar Peninsula was difficult to account for under present conditions, and gave him the idea that it was formerly the summit of a mountain. The question was, whether I had observed any signs of marine remains in this

locality higher than a height of about fifteen feet above the sea. To this I replied in the negative.

Cogitating over these matters, I have come to the conclusion that the probabilities are that the land in this neighbourhood was never, since the older rocks were elevated, at a lower level than about fifteen feet below that at which it stands at present, and that at some time, probably during the depression of the tertiaries, it attained a great elevation, possibly equal to the present extreme altitude of Tararua, viz., 5,000 to 6,000 feet, perhaps higher. At this time it is reasonable to suppose that Cook Strait did not exist, and that the islands were united.

If we follow up the main chains of Tararua and Ruahine to the northward we find a gradual rise of the tertiary beds which rest on the flanks of these mountains, attaining, at the Manawatu, a height of between 400 and 500 feet, and in the vicinity of the Kaimanawa range a height of 2,700 feet.

These rocks extend from eocene to pliocene, and many changes of level no doubt occurred during their deposition, but while in course of formation they must have been beneath the sea.

My supposition is, that previous to the time when they were in course of formation there was an oscillatory movement which depressed the more northern rocks and raised those in this vicinity; while, at the time when these tertiaries were raised above the sea level, the movement was in an opposite direction, the whole of the west coast tertiaries emerged and were raised at their northern limit to a great elevation, while the land in this neighbourhood was depressed until it sunk below its present level, and probably at the same time Cook Strait was formed and the islands separated.

I have formerly remarked on the various terraces which may be observed on the coast towards Terawiti, and have supposed them to mark old beaches, showing lines of rise of the land. As I think no remains of marine origin have been found in them, I now suggest that they mark the banks and various levels of an ancient river, the other bank having disappeared in the waters of the Strait. With a supposed high elevation and greater mass of land, we may suppose a larger river or rivers than any which we now possess in this vicinity, and some things may thus be accounted for which are difficult of explanation otherwise. Thus, if we consider the boulder and gravel formation which forms the isthmus between Evans and Lyall Bays, and on which the sand-hills are a mere excrescence, it is difficult at first sight to perceive where the boulders came from. No boulders or gravel are now washed up on either shore, and it is not perceptible why, if the land stood at a lower level of fifteen feet, boulders should then be thrown up. Still less could they be thrown up if the land stood at a higher elevation than it does at present.

I have come to the conclusion that at a time when the present entrance to the harbour was closed, and when Port Nicholson was a fresh-water lake, the boulders of the isthmus mark a river bar—not a bar at the mouth of the river, but a bar at the foot of a pool or lake and above a rapid—probably accumulated against a ridge of harder rocks. That this bar must have been re-arranged and altered by the sea at the time when the land was depressed some fifteen feet below its present level is sufficiently obvious, and accounts for its present appearance as having been latterly a marine boulder bank, under somewhat similar conditions to that at Napier, although different as lying between two bays.

When we consider the matter fully, it seems a necessity that Port Nicholson must have been formerly a fresh-water lake. The borings taken from the wharf showed the remains of land vegetation at a considerable depth. There are numerous other reasons to suppose that, with the exception of the before-mentioned rise of fifteen feet, there has been a long era of depression, and that consequently the land must formerly have stood at a much higher elevation. One feature is, I think, conclusive as to a certain amount of elevation, viz., the present entrance of the harbour. From the remains of Barrett Reef and other rocks it is evident that this entrance or passage has been excavated chiefly by denudation. Now, it is impossible to suppose this to have been done by the ebb and flow of the tide. The requisite effect is to be easily accounted for by supposing Port Nicholson to have been a fresh-water lake with an outlet in Evans Bay. From the erosion of the coast line the locality of the entrance of the harbour became weakened, the waters took that direction and scoured out the channel, leaving the old Evans Bay passage high and dry. Supposing the present entrance of the harbour closed, Port Nicholson would even now become a fresh-water lake, with an outlet in Evans Bay; and taking the mean elevation of the isthmus at fourteen feet above high-water mark, and supposing a depth of stream of only five feet, the waters of the harbour or lake would be raised so as to submerge a large part of the Hutt Valley.

On the other hand, taking the mean depth of the harbour and entrance at ten fathoms, if we suppose a rise of the land of sixty to seventy feet, we should have a fresh-water lake, although of diminished area, even with the present entrance open. I think it will be found that the barrier was originally sufficiently high to form a lake extending up the valleys of the Lower and Upper Hutt, and that the deposits which have filled these valleys are from the talus of the river drifts falling into a lake. There appear, in the Hutt Valley, to be deposits of heavy boulders succeeded by gravel and clays, and finally by fine alluvium, the latter lately covered by a magnificent forest, now almost entirely destroyed by man.

No strata of marine origin appear to be found in the Hutt Valley. Had

the gravels and clays which fill the basin of this valley been deposited in the waters of the harbour, which, on that supposition, would then have flowed up the valley, remains of marine origin must have been found.

The formation of Thorndon Flat, although difficult to account for without the assistance of the above theory, becomes comparatively easy when supposed to be a gentle deposit in a fresh-water lake. This I suppose it to be. The more I consider the question the more it appears to me impossible to suppose that Port Nicholson could have been for ages anything else than a fresh-water lake.

The question still remains for consideration how the basin of the lake and valley was originally excavated, for excavated it must have been.

Although unwilling, without due cause, to drag in the much-abused agency of ice, yet I must say that I think the most reasonable theory we can form on the subject is, that the great work of excavation was at least commenced, and in great part executed, by the agency of a glacier. If we suppose a great elevation of land in the neighbourhood, possibly including the whole of Cook Strait to Taranaki and Cape Farewell, and the still, at that time, undenuded state of the higher parts of Tararua, it is easy to conceive, or possibly difficult to resist, the inference that a névé crowned the higher plateau, and a glacier once filled the valley of the Hutt and the harbour of Port Nicholson, and so far excavated the valley as to prepare a basin for a lake and subsequent harbour. This would appear to me to be the simplest explanation of the changes which have taken place. It will be seen that the chief foundations for the theory are the peculiar denudation of the district and the boulder-bank in Evans Bay. With regard to the latter it is not necessary to suppose that the boulders were brought from a distance, for they might have been derived from the remains of the Evans Bay denudation. Some few boulders of granites and schists, which I have found on the isthmus, arrived there, no doubt, at a comparatively recent period, and since the re-arrangement of the boulder bank by the sea.

It may seem absurd to notice a curious idea of which many people seem to have got hold, from what information it would be difficult to determine, viz., that Captain Cook sailed into Port Nicholson through the passage of Evans Bay. The best authority on the subject ought to be Capt. Cook himself, and, as he does not mention his visit to this port, it is reasonable to suppose that his ships never entered it. But I think I have shown conclusively that he could not have entered by Evans Bay, for, even supposing that the land at the time of his visit to New Zealand stood at a lower level of fifteen feet—which supposition would require an extraordinary stretch of imagination—that depression would only allow about a foot or two of water at high tide for the passage of his ships, and, notwithstanding the smaller size of the vessels in those days, that depth of water was clearly insufficient.

No further depression of the land is permissible with the evidence at our disposal.

In the above theory I have been obliged to allow for vast changes in the elevation and depression of land, but if we consider that since the deposition of the tertiary strata a large part of Europe has emerged from the ocean, and that tertiary rocks have been elevated to a height of 5,000 feet in Sicily, and, if I remember right, also on the flanks of the Alps, it is surely not unreasonable to suppose that changes of equal magnitude may have taken place in the Southern Hemisphere. There can be no dispute that the tertiaries extending from Cook Strait towards Ruapehu and the Kaimanawa range attain an elevation in the interior of the island of 2,700 feet; and the tertiaries on the eastern side of Tararua reach, in the Puketoi range, a height of fully 2,000 feet.

If the above theory is a sound one it will be interesting for other observers to link the supposed changes of level with those which may have taken place on the southern side of the Strait.

The series of ancient valleys on the opposite shore of the South Island, which now form harbours and sounds from Cloudy Bay to the French Pass, are at once suggestive of depression, and certainly give the idea that Cook Strait is now the base of a synclinal curve, which, on the supposition of the correctness of my theory, formerly formed a horizontal line, or possibly an anticlinal curve.

It will be seen that I have given a liberal allowance of time, for the elevation I suppose must have been previous to the deposition of the older tertiaries.

That Port Nicholson was formerly a fresh-water lake can be proved without the necessity for much elevation, but the peculiar form and denudation of the land, together with the preparation of the valley basin, requires, I think, that we must assume a high elevation in former times.

Art. XLIX.—*Notes on the Glacial Period.* By A. D. Dobson, C.E.

[*Read before the Wellington Philosophical Society, 22nd September,* 1873.]

In a former paper,* which was merely a description of glacial remains in the Nelson Province, I suggested that the former extension of glaciers was due either to the much greater elevation of the land above the sea level at that period, or to the existence of land adjoining to the southward. Since writing that paper I have come to the conclusion that the last greatest glacial extension was due to a greater elevation of the land, and that, although other agencies—

* Trans. N.Z. Inst., Vol. IV., p. 336.

such as the wearing down of the mountains by glacial and other action, and the destruction of land by the sea—have all tended to render the climate less rigorous, the subsidence of the land has to be looked to as the chief cause of the termination of what may be called, for the sake of convenience, the glacial period.

On the west coast of the Middle Island the effects of glacial action, as exhibited by masses of moraine matter covering large areas, are so striking as to arrest the attention of even the most superficial observer. Struck by the recent appearance of many of the moraines, and the manner in which glacial drift caps the general drift of the country, I have ventured to collect the numerous notes I have made during the last ten years, and from them deduce what I conceive to have been the changes which have taken place during the latest geological periods.

At the end of the pliocene period I consider that but little of the Middle Island stood above water; the main back-bone of the island probably constituted a series of rocky islands, the sea level being about 2,000 feet higher during this period, which must have been of great duration; the gravel drifts were formed which cover the greater portion of the level lands, and cap all the older formations from Nelson to Hokitika. During this period were formed the Moutere Hills, and all that great face of drift hills which occupies the whole of the depression between the east and west ranges, from the southern shores of Blind Bay to Lake Rotoiti. Here the drift formation is interrupted by the mountains which divide the Lakes Rotoiti and Rotoroa, and also by the mountains forming the watershed between Rotoroa and the westward streams. Again, the drift formation occurs in the valleys of the Matakitaki and Maruia, and then continues on almost uninterruptedly, capping the older rocks throughout the flat country right down to the Mikonui River. Following the coast northwards from the Grey, the drift again occurs in all available places for deposition at heights varying from 10 to 500 feet above the present sea level. The reason for the drift attaining such a much greater height at the head waters of the Buller and Grey was, that there the drift was free from the destructive effects of stormy seas, and was deposited by streams flowing into a quiet strait protected by high land on the east and west, and was subjected only to the settling action of marine currents running through the strait; whereas on the coast line the heavy westerly swell from the Pacific, aided by the strong littoral currents, prevented the deposition of drift except in sheltered places.

It was during this period that the formation of the great gravel drift of the Canterbury plains began. The country there began to rise, and although the formation of gravel drifts continued on the lower levels, the waters of precipitation began to carve them on the higher levels into the forms

they now present. The elevating forces continued in action until the land was very considerably higher than at present; and, as the mountains were thrust higher into those colder regions of the air where snow does not melt, glaciers were formed in the deepest valleys, and, extending as the land rose higher, they reached those limits where we now find the enormous masses of moraine matter.

The period of the greatest extension of the glaciers marks the time of greatest elevation. After this subsidence commenced, and continued with slight local interruptions up to the present time, and is, in my opinion, still continuing. Moraine accumulations occur on the east side of the Southern Alps, chiefly at the lower extremities of all the large lakes, and form dams by which the lakes are partly formed. These are, by no means, the only places; I mention them as being those where moraine accumulations occur in the greatest mass, and are the most striking to an observer.

On the west coast the moraine matter occupies far more ground, and attains a much greater thickness, than is observable on the east side. From Bold Head southwards, as far as Jackson Bay, numerous cliffs form the coast line, which are the moraines of ancient glaciers. Lateral moraines run landwards, narrowing as the hills are reached, whilst in many places the final meeting of moraines has left low, irregular hills, entirely composed of loose masses of rock now covered with dense vegetation. Receding from the coast line, and examining the drift at the head of the main tributaries of the Grey, Teremakau, and Hokitika, the moraines are everywhere to be found, though very much smaller in size. This is due to the fact of the mountains being very much lower than they are to the southward. The Southern Alps culminate in Mount Cook, the range lessening in height to the south and north, besides being much more narrow, thus allowing less room for snow-fields. The moraine matter whenever found overlies the shingle drift, and in all the places which I have examined it shows no signs of having been under water or subject in any way to marine action, which could not possibly be the case if the sea had stood at any considerably higher level than it does at present, since the glacial period. The loose moraine mounds forming the cliffs near Abut Head and near the Poerua would be quickly levelled if subjected to the action of the sea. It is this undisturbed appearance which leads me to conclude that there can have been no general elevation of land since the glacial period. There is a marked absence of raised beaches; the few that do exist on the West Coast were, I consider, formed during the period of elevation, as they occur in several places at heights varying from 50 to 200 and 300 feet above sea level. They only occur in sheltered spots, and have been subject in many places to much denudation.

Briefly stated, my hypothesis is this: That the glacial period commenced

during a period of elevation, during which many of the existing raised beaches and auriferous leads were formed; that continued subsidence followed the close of the glacial period, and that subsidence is still continuing.

If this is correct we must expect to find traces of ancient beaches overlaid by glacial drift, and glacial drift at far lower levels than many of the beaches. Of the latter there are abundant examples south of Hokitika, where the morainic accumulations cover a great portion of the level country, which I have already described. Of the former there is an excellent example north of the Buller River, where the auriferous beach drifts on the slopes of Mount Rochfort are covered by a large mass of sandstone boulders derived from the Mount Rochfort sandstones, and evidently transported to their present position by glacial action.

In the foregoing the term "glacial period" means the last period of great glacial extension.

ART. L.—*On the Extinct Glaciers of the Middle Island of New Zealand.* By W. T. L. TRAVERS, F.L.S., a Governor of the New Zealand Institute.

[*Read before the Wellington Philosophical Society, 13th October,* 1873.]

THERE are few points of geological interest more strikingly brought under the notice of the traveller in the great mountain range of the Middle Island of New Zealand, than the evidences of the former extension of a glacier system, of which the numerous glaciers of the first order still occupying the valleys radiating from Mount Cook are, without doubt, a continuing remnant. Indeed, it is scarcely too much to say, that every great valley stretching into the main range, from one end of the island to the other, affords unmistakable proofs of having, at some time, been occupied by ice; and it is my purpose in the present paper, after making some general observation as to the bearing of this fact upon other geological questions affecting both islands, to describe, in some detail, the particular evidences of glacier action which are to be seen in the valleys of the Buller and the Dillon, two of the largest rivers in the Province of Nelson.

Now it must be evident that the disappearance of the enormous glaciers which, as will be seen in the sequel, formerly filled the upper parts of these two valleys—as well as of those which occupied the valleys of the Hurunui, the Waimakariri, and the Rakaia, in the Canterbury Province—must be attributed either to a singular change in climate, or to a great diminution in altitude above sea level of the mountain chain in question.

Those who are curious upon the first point, as a possible cause, will find

abundant suggestions for discussing it in the last edition of Sir Charles Lyell's "Principles of Geology"; but although the circumstances there indicated, as being calculated to affect the climate of the North Pacific, may have been instrumental, in some measure, in determining the height of the snow line in the latitude of New Zealand, I am nevertheless inclined, for the purposes of the present description, altogether to discard them from consideration, and to look to depression alone in order to account for the disappearance of the ice masses in question.

In this connection it must be observed that, except the summits of Mount Franklin (which is certainly not under 10,000 feet in height) and of a few of the higher peaks by which it is immediately surrounded, no part of the Middle Island range to the northward of the Mount Cook system at present reaches a greater altitude than 8,500 feet above sea level. In the Mount Cook system, however, it rises abruptly, attaining its greatest elevation (13,600 feet)* in Mount Cook itself; whilst the lower mountains in its immediate vicinity vary from 11,000 to 12,000 feet in height. It is, moreover, worthy of note—having regard to the continued existence of glaciers of the first order in this part of the Middle Island range—that its present altitude is very much the same as that of the greater portion of the Pennine Alps, a chain comprising the highest ground and the most colossal mountains in Europe, and which has always been distinguished by the number and extent of its glaciers.

We are unfortunately without special *data* for determining the actual position of the snow line in New Zealand, but many circumstances concur in inducing me to adopt, for the Middle Island mountains at all events, the same height above sea level as that which has been fixed by observation for the Swiss Alps, namely, about 9,000 feet. But it has also been ascertained that, in those portions of the latter mountains in which glaciers of the first order occur, the average depth of perpetual snow, *taken over the whole surface above the snow line*, is not less than 300 feet, and we may therefore fairly conclude —looking to the fact that some of the glaciers of the Mount Cook system may compare in extent with some of the largest of those which now occupy the valleys radiating from Mont Blanc—that the snow fall and the average depth of perpetual snow upon and around Mount Cook are much about the same in extent as in the case of the Swiss Alps. I need scarcely say, however, that these assumptions (as in the case of all others where no exact *data* exist) may contain elements of error, but not, as I think, to such an extent as materially to affect the general conclusions which I propose to deduce from them,

* The altitude of Mount Cook, as trigonometrically determined by Mr. T. R. Hacket, is 12,364 feet. I am not aware if this observation has been verified or disproved. See Geological Survey Report, 1869, p. 12.—[Ed.]

especially when taken in connection with the ascertained facts to which I shall call attention in the sequel. Assuming, then, that under existing climatal conditions an average elevation of not less than 13,000 to 14,000 feet would be necessary, in those parts of the Middle Island range which do not now exceed 9,000 feet in height, for the formation and existence of such glaciers as undoubtedly once occupied the valleys of the Hurunui, the Waimakariri, and the Rakaia—the highest summits in the vicinity of which do not now exceed the latter altitude—we must either accept a change in climate of a very remarkable character, but of which we have no evidence whatever, or attribute the disappearance of such glaciers to a diminution of not less than 4,000 to 5,000 feet in the general height of the range in question, as compared with its altitude when the glaciers referred to attained their greatest extension.

I may add that I am the more inclined to adopt the latter hypothesis, not only because the evidences in support of it are precisely the same as those which have led to similar conclusions respecting the former extension of the Swiss glaciers, but also because it is more in accordance with the principles which govern sound geological enquiry. One circumstance, moreover, is very noticeable in connection with the extinct glaciers to the north of Mount Cook, namely, that the extent of each appears to have borne a distinct relation to the altitude of the mountains in which it arose; for we find, not only with those which still occupy the Mount Cook valleys, but also with those which formerly occupied the valleys radiating from the Spencer Mountains, that the lateral moraines occur at far greater heights, and the terminal moraines extend to far greater distances, and are much more extensive in their dimensions, than those which were deposited by the glaciers which occupied any part of the range intervening between these two great mountain masses.

Assuming then that—at the time when the valleys above referred to were occupied by glaciers of the first order—the Middle Island range, generally, stood at an additional elevation of not less than 4,000 to 5,000 feet above sea level, not only must the present islands of New Zealand proper have been connected, but an immense area of dry land must have existed in all directions around them, probably extending, to the eastward, far beyond the chain of islands which curves round them on that side, from Raoul Island in the north, by the Chatham Group, to the Antipodes Islands in the south, all of which still bear a vegetation nearly identical with that of the parent land. To what extent the depression which led to the disappearance of the glaciers in question may have exceeded the maximum above referred to, I am not prepared to say, and, although both Captain Hutton and Dr. Haast have mentioned facts which lead to the belief that the eastern side of the Middle Island has risen since the last great depression, the extent to which this is indicated in their statements is too trifling to settle the question.

But the existence, in the localities referred to, of the ordinary evidences of glacier action, such as huge lateral and terminal moraines, of roches moutonnées, blocs perchés, etc., is not the only or even the chief circumstance of interest brought under our observation in connection with the former extension of the glaciers. On looking at a map of the Middle Island we cannot fail to observe a chain of lakes extending in an almost direct line from north to south, occurring chiefly, however, on the eastern side of the great range, and comprising Lakes Howick and Arthur, to the north of the Spencer Mountains; Lakes Tennyson and Guyon, on the eastern side of the same group; Lakes Sumner and Taylor, lying between the Provinces of Nelson and Canterbury; Lakes Coleridge, Lyndon, Heron, Acland, Tripp, and others, in the latter Province; and the more extensive Lakes Wanaka, Wakatipu, Hawea, and others, to the south of the Waitaki River. Now, it has never been doubted that all these lakes owe their existence as such, more or less, to the action of glaciers; those which occur to the north of the Waitaki, at all events, all lying in valleys above the lines of huge terminal moraines which have been deposited across them, and which have formed dams in many instances several miles in length and several hundred feet in depth.

It is, moreover, a matter of extreme interest that many of the larger valleys which, during the former extension of the glaciers, were occupied by ice, and are now filled with ordinary alluvial deposits, must for a long period after the disappearance of the ice have been filled with water to the height at which the glacier streams had then cut through the terminal moraines. In this condition they resembled, in every respect, the great majority of the existing valley lakes to the northward of the Waitaki River. An admirable example indicating the former existence of such a lake, in which the water has been replaced by alluvium, is to be seen in the upper part of the valley of the Dillon. In this case the moraine which stretches across the valley has an average width of about a mile, and extends down it for upwards of three miles, the fall from the point at which the river has cut through it on the upper side to that at which it discharges itself on the lower side being fully 180 feet, whilst the average slope of the valley for several miles above the moraine is less than 20 feet to the mile, but increases to at least 35 feet below it, indicating the great depth to which the moraine deposit extends below the present general level of the valley. The moraine itself rises, at its greatest height, about 100 feet above the level of the upper valley, and exhibits, in the angle which it forms with the mountains on the eastern side, and at a height of about 30 feet, a former lake margin, *as fresh and clean, and as free from vegetation and all other marks* (except the recent tracks of cattle and sheep), *as if the lake had been emptied only a week ago.* I have designated margins of this kind, which are usually composed of sub-angular shingle, as wave-margins,

indicating, as they do in all the existing lakes, the direction of the most prevalent winds, and usually running across the valleys in which the lakes are situated.

The moraine above referred to is about 24 miles below the main source of the river, and the lake which succeeded the ice could not have been less than 14 miles in length in the principal valley, with a branch at least five miles long in the tributary valley of the Ada. Of course it is impossible to determine the actual depth of the moraine deposit at its upper face, but even assuming it not to exceed 150 feet below the lake margin, we have an area of 19 miles in length and a mile in width, with an average depth of 60 feet, which has been filled with river alluvium (independently of the immense quantity of matter which must at the same time have been carried below the moraine) within the period which the river has occupied in cutting down the comparatively loose material of this dam, to a depth of 35 feet only.

It may, in view of such a fact, appear remarkable that the beds of the lakes on the northern side of the Spencer Mountains—which present on that side precisely similar conditions—should not also have been filled up; but I attribute the rapid accumulation of alluvium in the case of the Dillon Valley to the facts that the mountains bounding it are much steeper, are composed of more easily disintegrated rock, are in their upper parts very bare of vegetation, and therefore exposed to the alternate action of frost and heat, and moreover present in many places, for thousands of feet in height and for miles in length, little else than continuous slopes of broken stone; whilst those on the opposite side of the range are in a great measure densely wooded, and are chiefly composed of hard, crystalline rocks. I ought, however, to state that in assuming the moraine of the Dillon glacier to have a depth of only 150 feet below the lake margin above referred to, and in further assuming that the bed of the valley rises gradually from that depth to 0′, I am doing so without any ascertained facts.

I am not aware whether any measurements have been made in order to ascertain the depth of any of the lakes between the Spencer and Mount Cook ranges, with reference to the fall of the rivers flowing from them below the lines of their moraine dams; but the depth of Lakes Arthur and Howick, on the northern side of the Spencer Mountains, is very great as compared with the apparent depth of the bed of the valley of the Buller; whilst that of some of the larger lakes in the Otago Province, and notably of the Wakatipu, exceeds 1,100 feet, their beds, indeed, extending below the present level of the sea.

From a consideration of these facts, and of others which I have not thought it necessary to mention in so general a sketch, I think we are justified in concluding that these extinct glaciers originated during an upheaval of the

land, which extended to an altitude exceeding that of the present mountain chain by at least 4,000 to 5,000 feet, and that they attained their maximum extension coincidently with the maximum of elevation. They also lend strength to the assumption (founded on other independent grounds) that during the period of maximum elevation the land of which the present New Zealand islands proper are the chief remnant had a quasi-continental extension, chiefly to the eastward, and embraced, *at least*, the chain of islands above referred to. And they further justify us in attributing the disappearance of the glaciers in question to a depression of the land continued up to a comparatively recent period, a circumstance which, I think, is chiefly indicated by the following facts, namely :—That the larger number of the valley lakes which still exist above the terminal moraines of glaciers of the first order in those portions of the range in question which intervene between Mount Cook and the Spencer Mountains (as for example, Lake Sumner on the line of the Hurunui River), have been only partially filled up with alluvium, although the rivers which feed them are all shingle-bearing torrents ; whilst, on the other hand, the lake which succeeded the great glacier of the Dillon has actually been filled with alluvium within the period which its outlet has occupied in cutting down the moraine dam to a depth of 35 feet only, for a distance, having regard to the general fall of the valley, of little more than half a mile.

With regard to the probable time at which the upheaval referred to took place I can offer but few observations. So far as I can understand from the reports of the Geological Survey, we have no evidence of any upper marine pliocene beds in the Middle Island, whilst the upper portions of the miocene series are found at elevations varying from 1,200 to 1,800 feet above sea level. I therefore assume that the elevation in question commenced at the close of the miocene period, and that the more recent pliocene deposits within the Novo-Zealandian Province would only have been found on the outside boundaries of the quasi-continental area which existed when the elevation referred to attained its maximum, and were submerged during the subsequent subsidence of the land. The total elevation most probably approached 5,000 to 6,000 feet, the subsequent depression exceeding that by at least from 1,200 to 1,500 feet. At what time the depression ceased it is difficult to say, but it probably continued in pleistocene times, when a re-elevation of the land again took place.

The period which I have ventured to assign for this great oscillation of level would, no doubt, be considered immense if it could possibly be counted in years, but is certainly not too great for the effects produced. That the connection between the main islands and the Chatham Group must have been severed at a comparatively remote period is indicated by the fact that much

greater differences exist between their respective flora and fauna than exist between those of England and the continent of Europe, the connection between which was only severed in pleistocene times. It will at once be seen by those who have had an opportunity of perusing Dr. Haast's elaborate report on the Canterbury plains (presented to the Provincial Government of Canterbury in September, 1864), that the views contained in the foregoing brief sketch are altogether at variance with those which he there propounded in reference to what he has termed "the pleistocene glaciation of New Zealand."

Whilst giving reasons for his belief that the southern island of New Zealand has never been higher than it is at present, he nevertheless asserts that it was subjected, in earlier pleistocene times, to a general glaciation analogous to that of Greenland. His words are: "It is not necessary to give a picture of the desolate aspect of the country in those pleistocene times; but when reading the descriptions of Dr. Kane, of Greenland, and of other arctic and antarctic explorers, it brought visibly before my mind that this island during that era would have presented a very similar appearance." He, however, adduces no evidence whatsoever in support of this statement, nor does he attempt to account for the suggested glaciation otherwise than by a loose assertion "that the climate had changed by some physical causes, and assumed an antarctic character." For my own part I have never seen—at least in those portions of the South Island mountains which I have personally visited—the slightest evidence which could support such a statement, or which would have led me to the belief that, even during the greatest elevation of the land of which any indication remains, it presented features of glaciation differing (except in such degree as would naturally follow in this latitude) from those which it now presents where glaciers of the first order still exist.

In this connection the following extracts from the Duke of Argyll's address (in February of this year), as President of the Geological Society of London, have a distinct application to the existing physical features of the Middle Island mountains. His Grace says:—"If I may judge from a paper lately contributed by Professor Ramsay to 'Macmillan's Magazine,' upon the valley of the Po, and from the recent discussion on Mr. J. F. Campbell's very interesting paper on the glaciation of Iceland, it seems to be admitted by Professor Ramsay that no larger amount of work can be assigned to the glaciers of the glacial epoch than that of greatly deepening the valleys which existed before. If this be admitted, then the question of the effects of glacial denudation in determining the existing configuration of the surface of the earth becomes a comparatively narrow question. The existence of a glacial epoch, at least over a large part of the Northern Hemisphere, which, in its coming, its duration, and its passing away, has been the latest in the great agencies of change, is perhaps one of the most firmly established doctrines of

geological science; and if it be admitted, on the one hand, that when the period began it found the existing systems of hill and valley in the main determined, it must also be admitted, on the other hand, that it cannot have left them exactly as it found them. The intensity given to denuding agents by frost, or rather by the alternations between frost and thaw, is well known to be enormous; and it is impossible that a glacial period should have come on, should have endured for a long period of time, and should have gradually given way to a more genial climate, without having left upon the pre-existing surface powerful and lasting effects. But the conclusion that the glacial epoch deepened within certain limits pre-existing valleys, degraded to a like extent pre-existing hills, filled up estuaries with moraine matter, or with sand and gravel, or covered a great extent of country with boulder-clay, all this is very different from the conclusion that our existing systems of hill and valley, and even of sea and coast, have been all cut out of the solid by some great ice sheet of enormous thickness, which was quite independent of local glaciers, and which did not derive either the cause or the direction of its motion from the mountains which we now see." Further on, after referring to the present glacial conditions of Greenland and of the great antarctic continent, his Grace says:—"From observations such as these we may be assured, I think, of the truth of the theoretical conclusion that lofty mountain chains, with all their characteristic variety of surface, must, in all ages and in parts of the globe, have preceded the development of glacial conditions, and that in these chains the unequal elevations and depressions, which are the work of subterranean force, have ever been the guiding and controlling cause of glacial action."

Moreover, such a glaciation as Dr. Haast suggests in the report above alluded to must necessarily have obliterated all but the scantiest fragment of the fauna and flora of the country, leaving, indeed, at most but a few alpine forms struggling for existence amidst the inhospitable conditions by which they were surrounded; whilst, on the other hand, the study of the existing forms of life, and of those which have certainly become extinct within pleistocene times, has led all who have engaged in it to a conclusion entirely at variance with any such assumption. I propose, however, to deal with this question more fully in a future paper.

I will now proceed to describe, in some detail, the glacier phenomena presented to us in the upper parts of the valleys of the Buller and the Dillon, which I have selected as well marked types of those which are exhibited in other parts of the great mountain range of the Middle Island.

These two rivers, as well as many other of the larger rivers in the northern part of the island, have their sources in the great mountain system named by me the "Spencer Mountains," which occupy the centre of the tract of country comprising the Provinces of Nelson and Marlborough. The highest point of

this range is Mount Franklin—not over-estimated at 10,000 feet—whilst around it are several minor peaks averaging from 8,000 to 9,000 feet in height. The Buller River, which rises on the north side of the range, has its sources in Mount Travers, and empties itself, after a course of about 15 miles, into Lake Arthur, which, with the valley above it, lies between a spur of Mount Robert on the west, and the base of the St. Arnaud range on the east; the general trend of the valley and lake being due north. After leaving the lake the river flows to the westward until it reaches the sea, its waters being increased on its course by numerous large rivers, several of which have their sources on the western side of the Spencer Mountains. A line of road from Nelson, leading originally only to the Wairau Valley, now branches, in the heart of a great forest familiarly known as the "Big Bush," to the gold fields of the Inangahua and Lyell, passing through the valley of the Buller and the rugged gorge of the Devil's Grip. Almost immediately after leaving the point of junction the Buller road enters the line of an ancient moraine, along the flank of which it runs for several miles, until it opens a small valley excavated in the moraine itself, in a direction nearly parallel to the northern shore of Lake Arthur. Crossing this valley and ascending the moraine on the southern side of it the lake opens out, forming a noble sheet of water, which is seen stretching for miles into the great mountain range. The waters of the lake are of a rich blue colour, and throw up in bold relief the massive spurs of Mount Robert and of the St. Arnaud range, whose lower slopes, covered to the very edge with dense forest, dip abruptly into them; whilst far to the northward, closing in the view, rise the rugged snow-flecked peaks of Mount Travers. It is impossible to imagine a scene of greater beauty, unless we can look forward to the time when the shores of the lake will be studded with villas, giving to it that appearance of life and animation which are alone wanting to complete its loveliness.

Along the front of the lake, parallel to the small valley above referred to, lies a considerable portion of the huge moraine, rising from 100 to 150 feet above the level of the water, the outlet of which has made its way through it at its south-west corner, cutting it down to the depth of from 100 to 120 feet. On the opposite side of the valley, and about a mile and a half from the water, is a range of hills rising from 300 to 400 feet higher than the upper surface of the moraine, and which are composed chiefly of boulder beds, gravels, and sands, in no degree cemented, very little inclined in stratification, and in many places exhibiting perpendicular sections several hundred feet high, particularly in places where the foot of the hills has been washed by a river. The materials are all water-worn, and exhibit the common appearance of gravels and sands which have been deposited in quiet water basins. Captain Hutton, who accompanied me during a late visit to this locality, treats these beds as of

miocene age, but, as yet, there are no *data* from which this can be satisfactorily ascertained. They certainly overlie sandstones and shales of miocene age.

When the great moraine in question reached the flank of these hills it was deflected to the east and west, stretching in the former direction for three or four miles, and even crossing the watershed into the Wairau Valley, and in the latter for several miles down the valley of the Buller. This moraine is of stupendous dimensions, and was evidently deposited by a glacier which occupied the site of the lake and of the valley above it, and the surface of which, judging from the height of the lateral moraines, must have stood at least 1,000 feet above the present level of the water. The lake itself is several hundred feet in depth in its deepest part, the slope increasing from each extremity, but most rapidly from the lower end. It is difficult to account for the great depth of this lake as compared with the general slope of the valley of the Buller, unless we assume that before the elevation of the land its bed was filled with the same materials as compose the hills in front of it, and that these were gradually ploughed out or otherwise removed by the glacier. There can be no doubt, indeed, that a glacier will easily remove loose materials from a pre-existing depression to a depth considerably below the level of their surface on the lower side of the terminal moraine, or, in other words, will scoop out such materials to a depth greatly exceeding the general slope of the valley, but they cannot be removed unless forced more or less up a slope, and brought within the influence of the stream which issues from the foot of the glacier.

If, therefore, the site of Lake Arthur and of the valley above it, as well as of that part of the Buller which is now occupied by the moraine, was filled before the formation of the glacier with the same gravels and sands as compose the hills on its northern side, or with any other loose materials, I see no difficulty in believing that the portion of those materials which lay in the lake depression below the level of the general slope of the valley has been removed by the glacier, leaving the lake basin to be refilled by the alluvium which has, since the disappearance of the ice, been and is still being carried into it by the main river and by the innumerable streams which furrow the ranges on each side of it.

I have already alluded to certain facts in relation to the action of the glacier which formerly occupied the valley of the Dillon, but there are some circumstances of a special character in connection with it, which render it necessary that I should give more details of the physical features of the district, in order that my subsequent remarks may be understood.

The Dillon has its principal sources in the Pyramid Mountain, a huge peak to the north of Mount Franklin, and for the first ten or twelve miles of its course is fed by innumerable small torrents which drain the rugged slopes

of Mount Franklin and of the lower mountains between it and the Pyramid. About four miles below the former mountain it is joined by the waters of the Ada, a large stream, the sources of which are in Mount Una. The main valley lies nearly due north and south, and that of the Ada, which enters it about three miles above the great moraine already referred to, about north-west and south-east. The glacier which descended from the Pyramid and Mount Franklin being joined by an immense branch from Mount Una, passed down the main valley to a point below that of the Henry, damming back the waters flowing through the latter, so as to reverse the drainage and cause them to flow over a low col into the river Boyle, which joins the Dillon many miles below the great moraine. In the range of mountains which forms the eastern side of the main valley, and about five miles above the moraine, is a low col or saddle leading into the valley of the Stanley, which, after flowing for several miles on the eastern side of the dividing range, falls into the Dillon below the moraine. Before the glacier had filled the main valley the drainage of the mountains to the eastward of this col was carried into the Stanley River, but, as the col must have been considerably lower than the upper surface of the glacier, a branch of the latter passed over it, filling the valley below it (which lies about north-west and south-east) as far as the valley of the Stanley, in front of which it deposited an enormous load of moraine matter. This col is about three quarters of a mile across, and, no doubt, before it had been invaded by the ice, presented the ordinary features of a mountain saddle, namely, a smooth, rounded summit, with steep pitches into the valleys on either side. But the ice in its passage across it planed it down on the lower side to an even, uniform, and gentle slope for a distance of about half a mile, from which point it plunged abruptly into the valley below, not only scooping out all the material which had previously lain in its bed, but also, in all probability, deepening it somewhat, as a basin. Passing on then to the main valley of the Stanley, it deposited at its edge, and completely across the lateral valley, a huge mass of moraine matter, which extends back into the latter for about three-quarters of a mile.

The space between the col and the inner line of the moraine is now occupied by Lake Guyon, a sheet of water about a mile and a quarter in length and half a mile broad, and (by actual measurement) 60 feet deep in its deepest part, gradually shoaling, however, towards both ends. As the upper surface of the moraine is fully 100 feet higher than the highest part of the col, the drainage has been reversed, the waters of the lake flowing into the Dillon along a channel worn through the col. The scooping effect of the glacier is very evident in this case, for even the surface of the lake lies at least 60 feet below the general slope of the valley of the Stanley, which, in many places close to the great moraine, *flows through and over solid rock.*

Lake Guyon is being gradually filled with alluvium, carried into it by the streams which flow from the mountains on each side, and, indeed, it is already nearly divided into two separate sheets of water by a peninsula many acres in extent, which has been formed on its northern side by two of the largest of these streams. The amount of solid matter carried into it during heavy rains is enormous, and the circumstance that it has not already been filled is one of extreme interest, when considered in connection with the rapid accumulation of alluvium in the valley of the Dillon.

On the lower slopes of the mountain, immediately above the col, are innumerable roches moutonnées, many of them of great extent, beautifully rounded in general outline, but nowhere presenting the least striation. This, however, may be attributable partly to the fact that they are composed of the same sandstones as the great mass of the blocks deposited on the moraine, and partly to the circumstance that they weather with great rapidity under the alternate action of frost and heat, the disintegrated material being removed by rain.

The general conclusions which I have arrived at from a consideration of the foregoing, and other grounds, are :—

1. That the land of which the Middle Island is composed began to rise at the close of the miocene period, and attained its greatest elevation during pliocene times.

2. That it rose to an elevation of not less than from 4,000 to 5,000 feet greater than its present height above sea level.

3. That during the period of maximum elevation the land had a quasi-continental extension, chiefly to the eastward.

4. That during this period the land assumed its present physical aspect, and that as it rose glaciers were formed in the great mountain valleys.

5. That all the later marine pliocene deposits then formed were formed on the outskirts of the continental area.

6. That the glaciers, of which the evidences are to be found in those parts of the Middle Island mountains to the north and south of Mount Cook, owe their disappearance to a subsequent depression of the land, which continued during pleistocene times, during which a fresh upheaval subsequently took place.

7. That during this depression all the later marine pliocene beds of the Middle Island tract were again submerged.

8. That the Middle Island presents no evidence whatsoever of any such pleistocene glaciation as is mentioned by Dr. Haast.

I may add that, in addition to its picturesque beauty, the tract of country

referred to in the foregoing paper, and especially the part surrounding the Spencer Mountains, presents features which, properly investigated, are calculated to assist materially in solving many moot points in connection with the action of glaciers.

ART. LI.—*On the Glacial Action and Terrace Formations of South New Zealand.* By J. T. THOMSON, F.R.G.S.

(With Illustrations.)

[*Read before the Otago Institute, 11th February,* 1873.]

THIS paper is limited to the post-tertiary period, as will be seen by its designation, and the remarks are drawn from occasional observations that I have been able to make during these last seventeen years, while proceeding over the country in various directions on official duty in connection with the Survey Department. For the facts and figures availed of I am largely indebted to the work of the officers of the survey staff, as set forth in the topographical maps. As I have always been engaged in duties which claimed attention before the subject in hand, I bring forward my results as those of an occasional, and not those of a regular, observer. Much as I have travelled over this part of New Zealand, I have seldom had time to diverge from the trodden path to follow up or trace formations; my essay can, therefore, be at best incomplete, but if it induces those who have more learning and leisure at their command to pursue the enquiry, the time of this meeting taken up in listening to me will, then, at all events, not be entirely lost.

We live here, at this epoch, in what we settlers from the British Islands call the most agreeable temperature of the temperate zone, our annual mean being that of Devonshire, England. That the temperature should ever have been different, probably the earnest money-seekers of our fellow colonists have never enquired. To the members of this Society, who are lovers of science by natural bias, and who spend much of their time in seeking knowledge for its sake only, the question, if it has not arisen to their minds before this, will now interest them.

In the older formations abundant proof is to be obtained of the great alternations of heat and cold to which this world was subjected, information on which point is to be obtained from the works of Lyell, Ansted, and others. To notice these would be to take us out of the limits of the present theme, and to hold to it we must consider the old geological periods to have passed—to have performed their functions, as it were, in raising the mountains and

lowering the sea beds, in producing the contortions and anticlinations of strata, and in levelling and abrading their surfaces; again, and most of all, what affects man of this nineteenth century most nearly, in utilizing the products of the carboniferous period, by depositing them in our coal beds and alternating them, for this, our age of iron—the age of accelerated intercourse by steamships and railway—with the valuable black band. These events, then, have passed, and our consideration is confined to an epoch immediately preceding the present, and our range of actual observation to a small portion of the most remote of British colonies.

But we must pause a little yet, and borrow information from abroad, for we must not speak too abruptly of the glacial epoch, an epoch of constantly frozen ground, covering those pleasant spots where now the Taieri and Oamaru farmers gather in their golden crops of wheat and barley. We must look a little over the world, and, with the help of one of Keith Johnston's physical atlases, bring home certain facts to the mind. Our latitude is 46° south; longitude, 170° east. Now, there are two extensive regions in the world situated in the same latitude north, and ranging between 60° and 150° east, and 60° and 120° west, longitude, whose ground is constantly frozen, and whose glaciers, when on the coast, stretch down to the sea level, *i.e.*, in Asia and North America. The circumstance suggested to have existed in New Zealand has therefore extensive exposition on the earth at this present time. With so much of preface, then, in deference to the tender consciences of the doubtful, we may proceed with our demonstration.

That the limit of constantly-frozen ground overspread this region will not only have to be proved, I hope to your satisfaction, but that the present surface of the earth was also under water will have to be demonstrated. In support of this latter proposition, were I to appeal to your belief I think I would have ready concurrence, for this is an idea implanted in the mind by our earliest lessons, and, further, it is an universal one maintained by all nations, whether civilized or barbarous. But in this arena of philosophy you have a right to demand proof before belief, and I will shortly recount a few examples. In Europe the lofty Apennines and Pyrenees, in their limestone formations bearing marine fossils, convey a practical and convincing argument that their slopes, and even summits, were once below the ocean, and that they had either, in the course of geological ages, risen or the water had become depressed. And, as it has been in Europe, so it has been no otherwise with us, for we have the limestone in various parts of this portion of New Zealand bearing marine fossils now raised considerably above the level of the ocean.

First, I may mention, because it is nearest to hand, the Caversham freestone, attaining an elevation of 400 feet above the sea level, from which are gathered, as may be seen in the Museum, the *Terebratula*, *Pecten*, and other

shells; also the vertebræ of fishes of the whale species. Limestone formations of somewhat analogous structure are found in the Waitaki Valley, notable for their profuse possession of marine fossil remains (a list of which has been published by Mr. Traill), and rising with a recorded elevation of 1,059 feet above the sea; but, as the survey has not extended over the whole district, this is by no means the limit of elevation to which the formation attains. Then, again, in the Waihemo or Shag Valley, a limestone patch of the same age, and with similar fossils, occurs, rising to an elevation of 1,428 feet. At Waikouaiti another occurs, rising 531 feet. Many others are necessarily unnoticed, but mention may be made of those in the southern districts, such as Forest Hill, south end of Turingatura Downs, Point Pleasant, and Oreti plains; also, Orawia and Waiau, the limits of whose altitudes I am unable to obtain, but which vary from 200 to 1,000 feet above the sea.

Thus, over a confessedly limited area of New Zealand, ample proof is given of the surface of the land having been under the sea level, by these limestone formations carrying sea animal remains; and if we admit the depression to have been 1,428 feet, by actual observation, so may we admit a much greater if need be. Thus, while we see that the ocean had covered our dry land, so, in passing, I may bring to your notice that the converse had taken place.

In Europe proofs of this are abundant in the fossil trees and plants found in the coal mines at a depth reaching down to 2,500 feet below the ocean surface. Here, in the infancy of mining, we have but limited examples, but as sure in their indications as the others. These we have in the Shag Point and Molyneux coal mines, now being worked at the sea shore, and whose dip is under it; and at Green Island, where mining is now carried on below the sea level. Hence it comes home to the mind that the earth has had no rest, but rises and falls in the cycles of geology. But that it has been in practical quiescence for 100,000 years we also have close proof and ready assurance, as exhibited in the alluvial plain at the head of this harbour (Otago), whose formation must have required that, to our standard, enormous period, and whose surface shows no indication of rise or fall exceeding at most one or two feet.

Having gained one step in my essay, viz., that in the tertiary period our land had been much lower than it now is—for I may meet an objection which might be started, that these limestone formations might have been mere local upheavals, by stating this to be impossible, they lying on the older formations as their basis, and which they do not do at one part only, but in a manner enclosing half the circumference of the Province, and inserting themselves between the plutonic and metamorphic rocks of Stewart Island and the great western range of mountains.

The next step in my theme is to show that this region was within the

limits of constant frozen ground—that is, the region of glaciers and icebergs; and, in the first place, I use, as my stepping-stone, the remains of moraines that are to be, at this day, seen at the lower extremes of our interior lakes, three of which I have personally examined, viz., at Pukaki, Ohau, and Wakatipu. Here a geological lesson may be read as plain as the A B C, that the extremities of the glaciers—now only to be discovered in the far distance, high up in the recesses of Mount Cook, Mount Stokes, and Earnslaw—once reached to these lower levels, at which time they pushed forward rocks, stones, and masses of ice, in the manner that alpine glaciers do at the present day. The action may be termed that of *mountain* glaciers. The remains of the moraines are the proof of that action, and so of the existence of the glacier itself; but we have to do with glaciers of another description, preceding these, and far exceeding them in extent and influence. These I will term, for the sake of distinction, as *terrene* glaciers. The proof of the existence of these, with their accompanying icebergs, is to be found in the boulder deposits so numerous in many parts of this Province; and of those nearest at hand I may mention the deposits on the Kaikorai and Caversham ranges. Here the surface of the ground is bestrewed with them, and the cuttings of the road and railway works exhibit them imbedded in marl and clay, overlying the sandstone. At the various eminences of the ranges, they have served, by their having been deposited in clusters, to preserve the ground from erosion—even when that ground consisted of easily transported sand beds—and their original position is easily to be indicated on the spurs of the Waikari Hills, from whence portions of terrene glaciers stretched down the Kaikorai Valley to the ocean, bearing with them stones and material, and casting them off at intervals, as parts of the congealed masses broke off and fell into what, at that time, was the bed of the sea. But the most remarkable and extensive boulder deposit that I have seen exists at the gorge of the Kawarau and plains of Cromwell, strewed between the gorge and the town of that name in greater numbers as the gorge is approached, and placed in such a manner as small icebergs floating out of the valley would not fail to do, being parallel with the water's motion, and tending to the eddies on each side of the channel. Some of these boulders are larger than shepherds' huts, and being laid on the surface of the gravelly plain, far from their original locations, are a subject of wonder to the simple and unlearned. Boulders in the same manner appear below the Clyde Gorge, but not to so great an extent, yet in principle bearing out the same glacial action or floatage proceeding therefrom by icebergs.

Other proofs of terrene glaciers and icebergs are to be found in this district, in numerous boulders with striæ, or ice-scores, on them. I first had the pleasure of pointing out these to my friend, Mr. L. O. Beal, who read a paper to this society on a kindred subject. (See Trans. N.Z. Inst., Vol. III., p. 270.)

These striæ are not to be mistaken for harrow-marks, often seen on stones where fields are in cultivation. They are always found on the lower surface of the boulder as it lay on the ground bedded for ages, and by which position alone were the marks preserved from disintegration. They are never found on the upper surface of the stone, and are only to be sought for by turning over the block. At one of Sidey's fields almost every tenth stone has the ice scores on it, deeply indented in the surface, and which marks it had received in remote ages. Yet there are the marks, as patent and as certain as on the day they were made—a proof of ice action—a proof that this country was once the region of perpetual frost and snow, and unfit for the habitation of man.

The grooved rock in the Kaikorai Valley presents another lesson tending to the same conclusion. This rock juts out at a sharp turn of the main road, and appears at one time to have offered considerable opposition to the descending masses of ice, for over its whole surface grooves, nine inches to a foot in depth, are worn in the direction of the axis of the valley, and which have been preserved from disintegration by having been covered by a layer of clay after the ice action had ceased.

Thus, according to my limited observation, I have advanced such facts as have occurred to me, proving the ice-bound nature of the surface and shores of this island as it existed in remote ages of this recent geological period. More extended observations may be made by those having more time and opportunity; but I trust I have said enough.

While we may admit, then, that much colder temperature than now exists has been proved, so also the converse has to be accepted, though it be not necessary to the present argument. In Europe, the existence in prior geological periods of tropical vegetation is abundantly exhibited in the fossil remains of low latitudes, and, as a matter of near interest to us, in the case of one of these fossils the Norfolk Island pine is, in our age, the only remaining and living example. In New Zealand we have a parallel case tending to prove the same fact—the remains and gum of the kauri are found at this end of the islands, while the living tree is only to be found north of Auckland. No doubt, a more comprehensive knowledge of the geology of New Zealand, than I can claim to have, will confirm an alternation of temperature, not once, but for many times.

With these preliminary observations I may now proceed with the more immediate object of the paper. In looking over some of the topographical maps executed by the officers of the Survey Department, I was struck with the regularly curved beds of the valleys, notwithstanding that the country through which they wandered was of the most rugged and mountainous description. My attention was first drawn to the Manuherikia, a drawing of which is on the table, copied from a sketch which I made on its first exploration

in November, 1857. On plotting a section of the lower terraces, from the summit of the Hawkdun Mountains to Alexandra, I found the curve approach that of a conical section, excepting at that point below the mountains where the ford, instead of the terrace, had been given on the maps by the surveyors. This led me to surmise that—in the hollowing out or moulding, as may be, of a valley 45 miles in length, and 5,500 feet in depth from the apex of the culminating mountains to the lower river bed at its exit from the valley—there must be a law, a law that only the most obdurate materials can oppose. Thus the Manuherikia, in its course, crosses two great bars of schist rocks situated below the junctions of the Ida and Spottis, yet these bars appear to have had but a moderate influence in modifying the curve of the valley bed, as shown in the diagrammatic section.* The power of water alone could never have done this. Then, if it were with the aid of moving ice, at first blush I anticipated that the conic section would be a parabola, for here we would have the gravity of the ice tending downwards perpendicularly, with the flow of water tending horizontally.

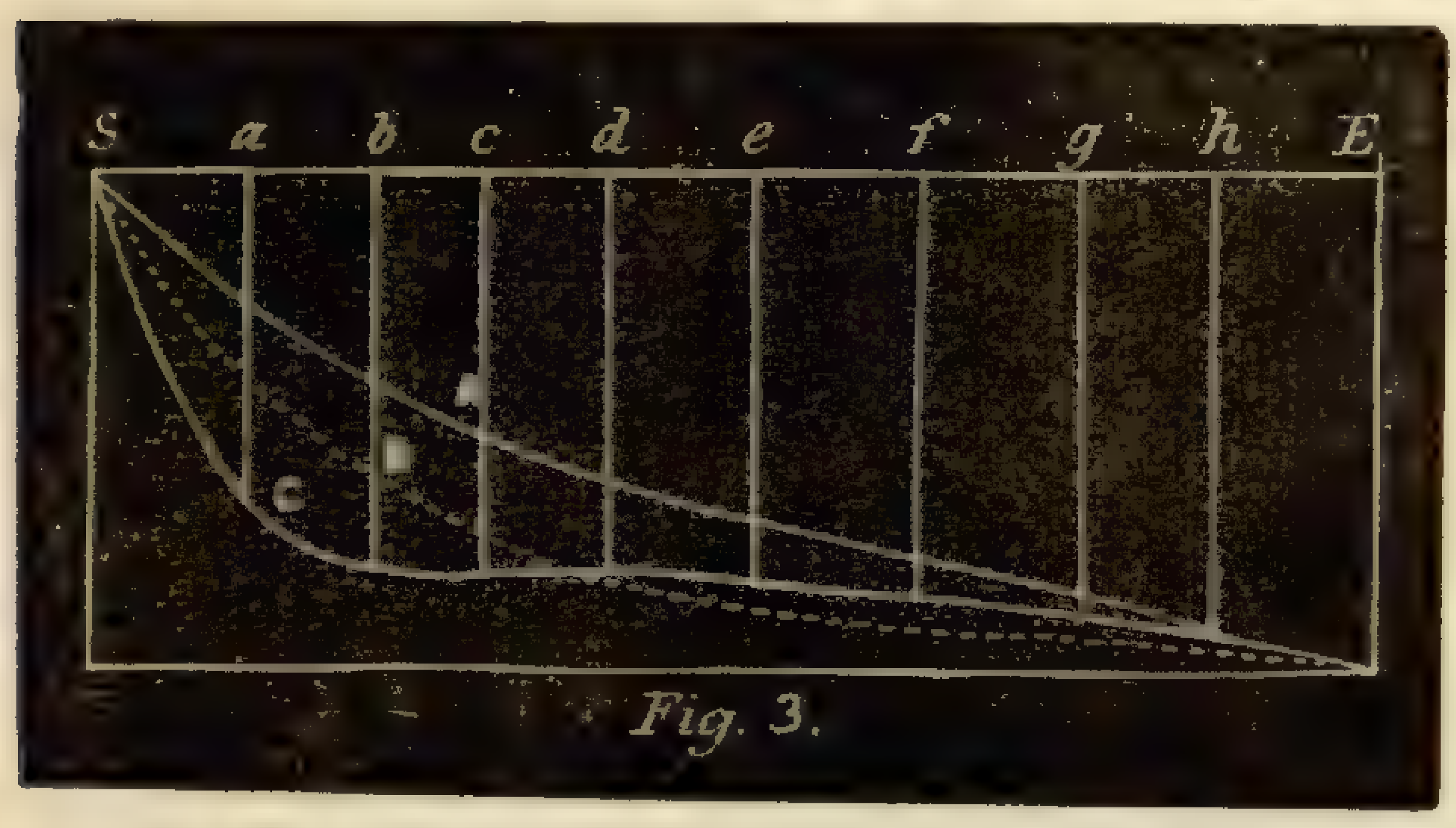

Fig. 3.

Comparing, therefore, the curve of the Manuherikia Valley, as shown by actual survey, with the parabolic one, we have VA the length of the valley, AB its rise from the exit to the source of its waters, and VC the distance of a point from V. Then VA and VC abscisses, and AB an ordinate being given, to find CD, the other ordinate; $\therefore \sqrt{VA} : \sqrt{VC} ::$ AB : CD $\therefore \sqrt{262,800} : \sqrt{35400} :: 5598 : 2054$.

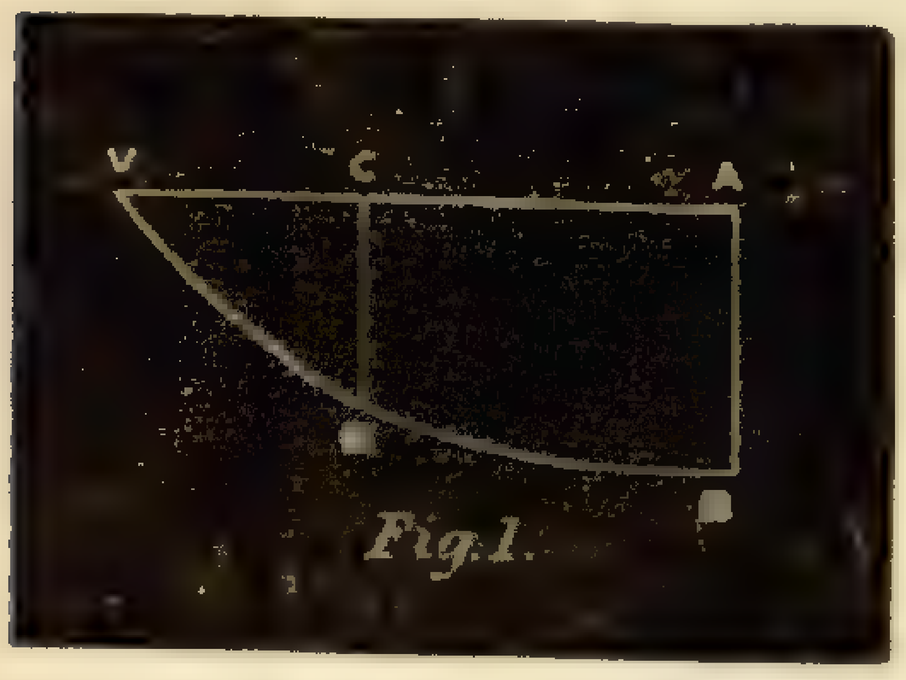

Fig. 1.

The other ordinates having been calculated in the same manner, as given below, afford us a comparison with the results of actual survey:—

		By Parabola.	By Survey.	Differences.
At source	(*a*)	0000 ...	0000 ...	000
Intermediate points	(*b*)	2054 ...	3625 ...	1571
	(*c*)	3272 ...	4307 ...	1035
	(*d*)	4172 ...	4987 ...	815

* Eleven sectional plans were appended to this paper, to illustrate the curves of the different valleys described. But as the same principle is repeated in each case, and the *data* for the construction of the valley curves are given in the text, the above general diagram has been substituted, in which S is source of river; SE—length of valley; A—parabolic curve; B—the elliptic, and C—the actual curve from survey; *a*, *b*, *c*—the intermediate points. The difference between the two curves B and C has been slightly exaggerated for the sake of clearness.—Ed.

		BY PARABOLA.		BY SURVEY.		DIFFERENCES.
Intermediate points	(*e*)	4776	...	5207	..	431
	(*f*)	5130	...	5251	...	121
At exit	(*g*)	5598	...	5598	...	000

Thus, as will be observed by these differences, and the form of the parabola, the curve of the valley bed does not conform to the same. It was evident that the hyperbola would be yet more unconformable. The ellipse was then tried with the following results:—Let VA the length of the valley, AB its rise, and VC the distance of any intermediate point from V be given, to find CD. Let A be the centre of the ellipse, then VA will be the semi-axis major, AB the semi-axis minor, VC and CZ will be abscisses to the ordinate CD. $\therefore$ VZ : BE :: $\sqrt{\text{VC} \times \text{CZ}}$: CD. Again, VZ and BE being double of VA and AB, we have $525600 : 11196 :: \sqrt{35400 \times 490200} : 2804$, the ordinate required.

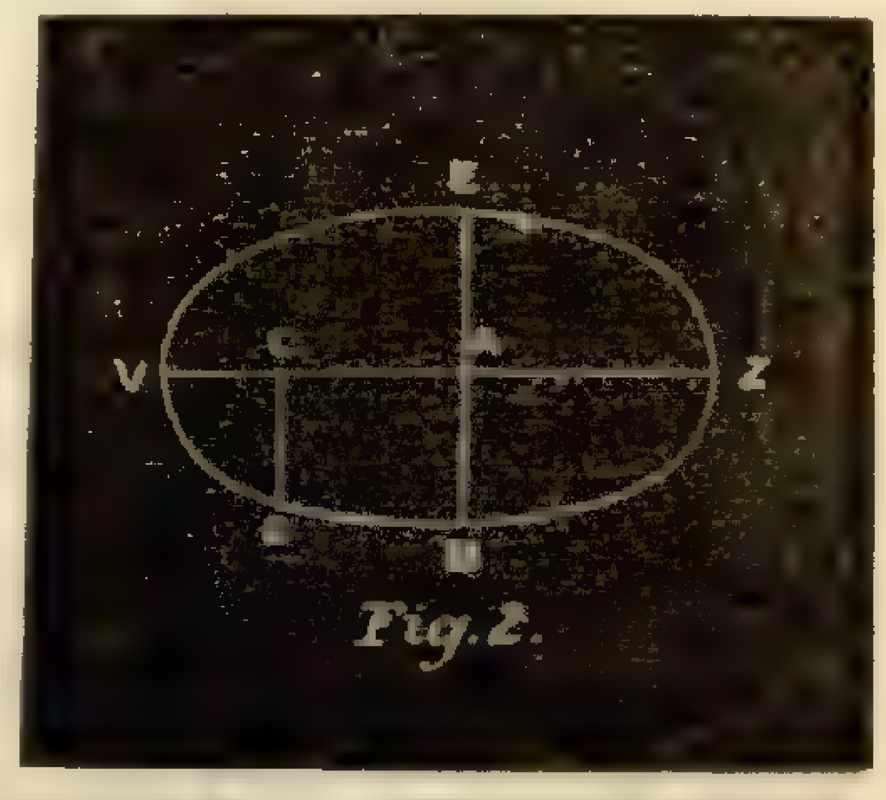

Fig. 2.

The other ordinates having been calculated in the same manner, afford the following comparison:—

		BY ELLIPSE.		BY SURVEY.		DIFFERENCES.
At source	(*a*)	0000	...	0000	...	000
At intermediate points	(*b*)	2804	...	3625*	...	821
	(*c*)	4212	...	4307	...	95
	(*d*)	5012	...	4987	...	25
	(*e*)	5384	...	5207	...	177
	(*f*)	5523	...	5251	...	272
At exit	(*g*)	5598	...	5598	...	000

As the *data* of the actual survey are given for the lower terraces close to the river, I may state that these vary from 80 to 100 feet in difference of level from the river surface. The point marked with an asterisk, as stated before, is also given, not for the terrace, but for the ford, which accounts for so great a difference; otherwise it will be seen that the actual curve of the bed of the Manuherikia agrees surprisingly with that of the ellipse, and, where it differs materially, such deviations are in the positions to be expected, viz., where the eroding forces have had to expend themselves on the hard bars of schist rock already alluded to as crossing the valley. Here, then, we have in our first tried example a valley bed, whose length is 45 miles and difference of level 5,598 feet, conforming practically to the curve of the ellipse. That such might be a rule with other valleys was then surmised, though, no doubt, modifications would take place from peculiar contour of country and other natural obstructions.

The next valley, then, which the *data* in the Survey Department enabled me to test was the Waitaki. The length of the Waitaki, from its source in the Mount Cook ranges to the sea, is 720,080 feet, and the altitude of the

mountain out of which it issues 8,500 feet. Testing the curve of the valley bed by the elliptic curve, in the same manner as given for the Manuherikia, we find the following result :—

		By Ellipse.	By Survey.	Differences.
At source	(a)	0000	0000	000
At intermediate points	(b)	6672	7123	551
	(c)	7834	7725	109
	(d)	8411	8138	273
	(e)	8475	8291	184
At exit into sea	(f)	8500	8500	000

The Waitaki is about 140 miles in length, rising some miles to the north-east of Mount Cook, whose elevation is 12,460 feet, and a painting of which is lying on the table, the copy of a sketch that I made when exploring the country in December, 1857. The scenery is the most grand and rugged in New Zealand, and can scarcely be surpassed in barrenness and wildness in any part of the world. I, at that time, with the privilege of an explorer and surveyor, named the feeding waters of the Pukaki Lake "Upper Waitaki," and their valley "The Valley of Sand." Dr. Haast, following me some years afterwards, has, no doubt inadvertently, altered these names to "Tasman," and the great mountain next to Mount Cook, which I, appropriately I opine, named "Mount Stokes," he has altered to "Sefton." From its alpine valley the Waitaki issues out on the Mackenzie Plains—named after a notorious sheep-stealer, by way of relief to the other good names in the Province—passing in its course through the Pukaki Lake; from thence it pierces the deep gorges of the Ben More and Kurow Mountains, after which it issues on the Waitaki Plains, near the sea. That one of the largest rivers in New Zealand, such as this, in passing over so many obstacles, should yet have its bed in such near conformity with the curve of the ellipse, was again striking, and wherein the divergences occur just where the mountain and rock obstructions are greatest. Thus a law of erosion of great power was again indicated, and so further enquiry stimulated; and I may here remark that while one great abrasion of surface has undoubtedly taken place, another, of no less significance, is exhibited by the section in the upper valley and Pukaki Lake—the effect of the action of mountain glaciers, whose effects have already been pointed out by my friend Mr. McKerrow (Trans. N.Z. Inst., Vol. III., p. 254), and to which subject I may recur.

Leaving the Waitaki Valley, I then proceeded to investigate the levels of the bed of the Shag River. This river has a short course of about 39 miles, having its source in Kakanui Peak, whose elevation is 4,978 feet above the sea. The river has a course through very rugged country; it is very tortuous, yet the section proves another very close approximation to the ellipse. For the calculation of the ordinates, we have: length of valley equal to 199,700 feet,

rise 4,978; from whence the following comparison was made, with actual survey *data*:—

	By Ellipse.	By Survey.	Differences.
At source	0000 ...	0000 ...	000
At intermediate points	3548 ...	3934 ...	386
	4390 ...	4541 ...	151
At exit to sea ...	4978 ...	4978 ...	000

Again, taking the survey *data* of the Taieri River, we find the same conformity. This was less to be expected than in the preceding rivers, as its course is more than ordinarily tortuous, rising, in the Lammerlaw, at a distance of only 35 miles from the sea, yet it has a total length of nearly 128 miles. Here again, where the country is free from rocks and mountains, its bed approaches the ellipse; where the course is obstructed by hard rock and precipitous hills, as in Strath Taieri, it is modified in the manner due to the indicated cause.

For the calculation of the ordinates we have: length of valley equal to 640,920 feet, rise 3,820 feet; from whence the following comparison was made, with the *data* given by actual survey:—

	By Ellipse.	By Survey.	Differences.
At source	0000 ...	0000 ...	000
At intermediate points	2476 ...	2620 ...	144
	2993 ...	2834 ...	159
	3523 ...	3165 ...	358
	3776 ...	3802 ...	26
At exit to sea ...	3820 ...	3820 ...	00

So far encouraged, I next investigated the levels of the Molyneux or Clutha, using such points as had been settled by actual survey; and here I first met with apparent non-compliance with my rising convictions. The properties of the Clutha appeared to differ from all other rivers yet investigated. Its course was seen to cross the great valley systems of this part of New Zealand, and its source would have more fairly belonged to the western slopes of the great backbone of the Middle Island than to the eastern. It passes through the Wanaka Lake (a painting of which is on the table, taken by me on its first discovery, in December, 1857) within 26 miles of its fountain, which I have placed in Mount Nix, but which might as fairly have been placed in Mount Brewster on the opposite side of the valley, or in Haast's Pass, at the low elevation of 1,716 feet. Leaving the Wanaka it crosses the great hollow that stretches from Timaru, by the Lindis, Kawarua, and Dome Passes to Invercargill; then it pierces the Dunstan range; then it crosses the hollow of the Manuherikia and Pomahaka; after which, piercing the Beaumont Gorge, it issues in the plains and delta near the sea. Thus, while its course runs counter to prior experience, its levels are also equally divergent. It will be observed that, though the divergence is more at the ordinate nearest its

source, yet this principle prevails that the curves gradually approximate, showing that had the source been accepted at a lower point than Mount Nix, the law would have been vindicated.

For the calculation of the ordinates of an ellipse for the valley of the Molyneux, we have: the length equal to 944,040 feet, rise 9,101 feet.

	By Ellipse.	By Survey.	Differences.
At source	0000 ...	0000 ...	000
At intermediate points	5050 ...	8127 ...	3077
	7405 ...	8477 ...	1072
	8084 ...	8601 ...	517
	8670 ...	8890 ...	220
	8781 ...	8929 ...	148
	8886 ...	8951 ...	65
At exit to sea ...	9101 ...	9101 ...	00

The next valley that the maps of the Survey Department enabled me to examine was that of the Cardrona, a rapid mountainous torrent flowing into the Molyneux near to its issue from Lake Wanaka. The length of the valley is about 31 miles, and the rise, from the Molyneux to the Crown Mountains, 4,799 feet. This example, considering the features of the mountain district, shows a tolerably near approximation to the ellipse, as given below:—

	By Ellipse.	By Survey.	Differences.
At source	0000 ...	0000 ...	000
At intermediate points	3433 ...	3923 ...	490
	3609 ...	4000 ...	397
At exit	4799 ...	4799 ...	000

The last example with which I will trouble you is that of the Mataura, with its east and west bends, a painting of whose scenery is on the table, taken on its first exploration, in January, 1857. The east branch being the shorter is not properly the main river; it will thus be seen that its curve is not so near the ellipse as the other, but both are exceptional to the general rule, and curve more under the classification of the Molyneux; the western branch crossing the low depression already mentioned that stretches from Timaru to Invercargill, and both crossing the remarkable valley that stretches from Molyneux Bay to Lake Te Anau. Thus the features of its bed have the same remarks applicable as have been made in regard to the Molyneux. The comparison of the east branch gives the following results:—

	By Ellipse.	By Survey.	Differences.
At source	0000 ...	0000 ...	000
At intermediate points	3201 ...	4547 ...	1346
	4216 ...	4773 ...	557*
	4620 ...	4905 ...	285
	4904 ...	5009 ...	105
	5110 ...	5129 ...	19
	5173 ...	5160 ...	13
At exit to sea ...	5224 ...	5224 ...	00

and the west branch, as follows:—

	By Ellipse.		By Survey.		Differences.
At source	0000	...	0000	...	000
At intermediate points	5295	...	6034	...	739
	5494	...	6079	...	585*
	6209	...	6315	...	106
At exit to sea ...	6530	...	6530	...	000

It may be remarked here that the points marked with an asterisk being common to both branches, viz., 557 and 585, the near agreement from such widely diverging *data* seems to tend to prove a common principle, such as it has been my object to illustrate.

Having thus endeavoured to follow out the indications of a law that nature pursues, in scooping out the beds of the valleys on the face of the earth, I will now point out one or two examples of extensive abrasions as collateral or confirmatory evidence of some great eroding power acting, which does not exist in this latitude at the present day. Taking a position near to Dunedin, we have the Kaikorai stream, a small mill power issuing from the south end of Flagstaff Hill. This streamlet pursues its course till it falls into the lagoons near Green Island. On examination it will be found to run in a well-defined and permanent bed, within which it would appear contented to remain to eternity—if its once pellucid waters had not been sacriligiously interfered with by wool-scourers, tanners, and railway contractors—yet do we see that it has had prepared for its tiny little self a capacious valley of 600 to 6,000 feet in breadth, and 150 to 200 feet in depth. That this valley has been scooped out for the dignity of the little stream is amply proved by the Caversham fossil-bearing limestone of the tertiary period, bounding it almost continuously to the eastward, and underlying it, also showing itself frequently on the western side. The strata of this limestone further give evidence, by its deposition and strike, that it once filled up as level land what is now a spacious valley. If the scooping out of this valley be sought to be accounted for by the petty stream now running through it, we would indeed have a monstrous effect from the most puny of causes. The causes must certainly be sought for elsewhere. Again, on the northern seaboard, we have the immense formations of Oamaru limestones stretching along the coast and up to the mountains. These, again, have been eroded and carried away by forces issuing from the valleys and gorges of the interior, and acting on them in a manner that adheres to a principle, viz., the erosions widen with the distances from the gorges, and creating along the limits of their influence steep and straight lines of escarpment which, at this day, display the interesting cliffs of fossiliferous strata of that district.

The erosions of the Waitaki, 300 to 500 feet in depth, extend 40 miles into the interior, of $\frac{1}{4}$ mile in width at the gorge, and 10 miles in width at the sea shore; of the Kakanui, 20 miles, with a varying width of $\frac{1}{8}$ of a mile to 1

mile ; and of the Waiariki, 10 miles, with a varying width of $\frac{1}{8}$ to $\frac{1}{4}$ of a mile. Thus has the undulating and varying surface of this part of our territory, during the post-tertiary period, been moulded to its present form, great valleys have been scooped out, and hills removed. Under what conditions, then, could these mighty works have taken place, is a question now to be considered.

To approach this question we must now turn to higher latitudes, and fortunate it is that a solution is to be attained not far distant, through the discoveries and researches of the eminent explorer Sir James C. Ross, whose works I read, with intense interest, in 1848, and which I have the pleasure to lay on the table. Just 23 degrees due south, *i.e.*, only six days distant by steam vessel, lies South Victoria, a region which now possesses the climate that New Zealand had ; whose physical geography is the same ; and, being volcanic, may be said to be a continuation of our colonial territory. The beautiful drawings given in the work display the same serrated ridges which are now to be seen in our great western mountains (see Reid's Antarctic Voyages Vol. I., page 183), and the smoking summit of Tongariro is to be discovered in that of Mount Erebus (see page 216, Vol. I.). To illustrate the subject, I cannot do better than transcribe the explorer's own words. He says:—

"It was a beautifully clear evening, and we had a most enchanting view of the two magnificent ranges of mountains, whose lofty peaks, perfectly covered with eternal snow, rose to elevations varying from seven to ten thousand feet above the ocean. The glaciers that filled their intervening valleys, and which descended from near the mountain summits, projected in many places several miles into the sea, and terminated in lofty, perpendicular cliffs. In a few places the rocks broke through their icy covering, by which alone we could be assured that land formed the nucleus of this, to appearance, enormous iceberg."

Again : "The height of Mount Sabine was found, by means of several measurements, to be rather less than ten thousand feet, and about thirty miles from the coast. The elevations of the other mountains were not determined with accuracy, but we judged them to vary from seven to nine thousand feet ; and, altogether, they presented as grand and magnificent a view as can well be imagined."

Again : "We found the shores of the mainland completely covered with ice, projecting into the sea."

"We stood to the southward, close to some land which had been in sight since the preceding noon, and which we then called 'High Island.' It proved to be a mountain 12,400 feet of elevation above the level of the sea, emitting flame and smoke in great profusion. At first the smoke appeared like snow-drift, but, as we drew nearer, its true character became manifest. The discovery of an active volcano in so high a southern latitude cannot but be

esteemed a circumstance of high geological importance and interest, and contribute to throw some further light on the physical construction of our globe. I named it 'Mount Erebus,' and an extinct volcano to the eastward, little inferior in height, being by measurement 10,900 feet high, was called 'Mount Terror.'"

Again: "At 4 p.m. (January 28th, 1841), Mount Erebus was observed to emit smoke and flame in unusual quantities, producing a most grand spectacle."

Again: "We made good progress to E.S.E., close along the lofty, perpendicular cliffs of the icy barrier. It is impossible to conceive a more solid-looking mass of ice; not the smallest appearance of any rent or fissure could be discovered throughout its whole extent, and the intensely bright sky beyond it plainly indicated the great distance to which it extended to the southward."

Again: "This extraordinary barrier of ice, of probably more than a thousand feet in thickness, crushes the undulations of the waves, and disregards their violence. It is a mighty and wonderful object, far beyond anything we could have thought or conceived."

Such is the description by an experienced arctic and antarctic voyager of a land such as New Zealand had once been in the glacial epoch, and I beg to refer you to page 232, vol. 1, of his work for an admirable drawing of the south polar barrier of ice which he discovered, and which rises 160 feet above the sea level, being also 1000 feet thick and 450 miles in length. With these facts before it, then, the mind may be presumed to be in preparation to perceive how the great erosions of surface had taken place here. The effects we see, and the power, indeed, is undeniable; for within six days' steaming from this we have the very extremes of the terrene glaciers, which have for ages been subject to the melting influence of the sea, yet maintaining a thickness of 1,000 feet, then in the valleys and at the mountain bases we have a right to conclude that in such places the glaciers may exceed 2,000 to 3,000 feet in thickness. Such being the case, then, the eroding force is only a matter of mere rule-of-three calculation, as below:—

Ice weighs 59lbs. per cubic foot. Ice, then, 1,000 feet in thickness will have a crushing power of 409lbs. per square inch; of 2,000 feet, 818lbs.; and of 3,000 feet, 1,227lbs. Now, chalk, according to Rankine (which has about the consistency of Caversham limestone), is crushed under a weight of 330lbs. per square inch. Thus, in the glacial epoch, would the Kaikorai Valley be scooped out by nature in as easy a manner as the potter's tool shapes the clay vessel. Limestone, such as most of that to be found on the Oamaru Plains, crushes under 2,200lbs. per square inch; this, then, with the alternate clays and soft shales, under half or third of the pressure, would yield to the glaciers of the thickness above given when in motion; and, when not in motion, yet the more readily by the power of water, under hydraulic pressure, finding its way

out to sea between the ice and the earth, bearing with it the hard gravels drawn from the interior mountains, which would act as an abrading substance, in the manner that emery polishes even steel. It is thus that we see the Waitaki Downs levelled to their mathematical curves, but this only where the glacial forces could have acted where the downs have been protected by the position of the intervening Kurow Mountains; there they remain in preservation, and we see the lesson of the past as shown in the experience of the present, when our antarctic voyager remarks, as already quoted, of South Victoria mountains, that "the glaciers filled their intervening valleys, and which descended from near the mountain summits, projected several miles into the sea, and terminated in lofty, perpendicular cliffs." Such, then, was the face of nature on our shores, and such the action that formed our valleys and stretched out our plains. South Victoria Land, our neighbour in the great Pacific Ocean, is now undergoing the process of the great glacial action with which we are done, and which I have feebly attempted to illustrate. There now, at that short distance from us, is the glacial age; ours has passed and gone many hundreds of thousands of years ago, when our age was then, and at that time—in the simple but sublime language above given—a glacier filled the valley of the Waitaki, descending from the mountain summits, and projecting several miles into the sea, terminated in lofty, perpendicular cliffs. This wild scenery did not exist at the Waitaki alone, but was the character common to all our valleys and our coast lines.

Now, as the effects of glaciers have been apparent in our valleys, so will they be seen also in our hills and ridges, scoring them out into angular gutters and ravines, in the direction of least resistance, from the tops or watersheds, thus proving a strict adherence to the directions that bodies would take impelled by their gravity, and, in so doing, wearing away or scoring out the slopes, however hard their formations be, or however uncompliant their strata—this, of course, with modifications. On the table are some illustrations of this action, supplied from the topographical surveys of the Province. Supposing the lower hills and surfaces of the Province to have glaciers superimposed, their effect could be no otherwise, for, as they melted annually during the summer influence, the water would find its way between the ice and the earth, and so gradually work out a channel to the valleys by its nearest and readiest access. This done, as the first process, then, in time, would the overlying congealed masses break up by fracturing on the edges of the ridges, and by sliding down into the valleys assist disintegration of the surface by their weight, and so enormously increase the erosion begun in the first place, in a minute manner, by the water. Hence the furrowing of the hills and ranges so remarkably general in this part of New Zealand.

Having said so much, I may now proceed to terrace formations. The

most striking are those of the Upper Clutha, near Cromwell; of the Manuherikia, near Alexandra; and of the Mataura; but they are found everywhere —from near the mountain tops to the sea shore—having the greatest dimensions to the most diminutive. Those of the Upper Clutha—a type of the former—rise 200 to 300 feet, looking in the distance like a huge wall, and attracting the astonished gaze of the beholder.

These terraces are found to consist of shingle and gravel, bound more or less loosely by clay and sand, *i.e.*, where the prior, or tertiary, deposits are not yet preserved from abrasion and transport; and this principle universally prevails—that the shingle becomes larger as you approach the mountains, and smaller as you near the sea. Thus there has been a law of deposit: the particles becoming smaller as the transporting power became weaker. Further, there has also been a law of deposition and formation, for the terraces incline as you close in with the mountains, and they tend to be level as you leave them, and only becoming perfectly level on the sea or lake shores. And here I may remark that in this part of New Zealand I have missed detecting any raised beaches, so frequently spoken of by European geologists, excepting on Lake Wakatipu, where those that exist there have been formed by the unusual circumstance of the lake once having an outlet by a different direction than the present one, and at a higher level, viz., by the valley of the Mataura.

In illustration of the varying inclination of terraces, I beg to adduce the following facts from actual survey. Commencing from the sea shore at the Waitaki plain, and following up the lower terrace parallel to the river, we found—

From	Z to X,	Papakaio,	in distance	14,400	feet,	the rise is	52	feet, or	3·6	per 1,000.
,,	X to V,	,,	,,	10,600	,,	,,	40	,,	3·8	,,
,,	V to Q,	,,	,,	13,400	,,	,,	59	,,	4·4	,,
,,	Q to R,	,,	,,	12,700	,,	,,	22	,,	1·7	,,
,,	R to S,	Awamoko	,,	14,300	,,	,,	25	,,	1·7	,,
,,	S to G,	,,	,,	10,300	,,	,,	29	,,	2·8	,,
,,	G to X,	,,	,,	25,600	,,	,,	77	,,	3·0	,,

It is so evident that the cases are similar with the terraces of the Molyneux, Taieri, Mataura, and other large rivers, near their mouths, that to detail them would be tedious and of no use; we therefore go at once to the interior. On the Manuherikia the following are the inclinations of the terrace that abuts near Alexandra:—

From	W to K,	Liang Rock,	in distance	12,300	feet,	the rise is	84	feet, or	6·8	per 1,000.
,,	K to H,	,,	,,	9,100	,,	,,	99	,,	10·8	,,
,,	H to E,	,,	,,	13,200	,,	,,	234	,,	17·7	,,
,,	E to C,	,,	,,	16,000	,,	,,	1,250	,,	78·0	,,

At the Upper Clutha, with one terrace abutting near Cromwell—

From H to I, Cromwell, in distance 16,400 feet, the rise is 728 feet, or 44·3 per 1,000.

And, with another terrace abutting near Wakefield—

From J to K, Cromwell, in distance 12,400 feet, the rise is 731 feet, or 59·0 per 1,000.

Thus, there is a law indicated in the nature and formation of these terraces,

and when we examine their contents we find that they consist of particles of broken, worn, and ground-up rocks, whose originals are in the enclosing mountains; hence, as travelled particles, we conclude they come from thence.

To estimate the importance of the power that brought them to their present site is, for the human mind, difficult. The formation of the Manuherikia I roughly estimate at 900 feet in depth, 4 miles in breadth, and 20 to 30 miles in length; those of the Upper Clutha may be one-third less than these. Then, if we were to try to imagine what power would transport the Peninsula of Otago to Green Island, we would have some notion. We are, then, conclusively led to the glacial action that we have been already considering for a satisfactory solution of the problem. This alone could do the work, and this—on pondering on what has already been adduced—would do it so naturally that I need not take up more of your time on the subject, but rather confine myself to an explanation of the *modus operandi*.

It has been proved, I hope to your satisfaction, that terrene glaciers at one time covered our island, and that also the island itself was sunk considerably under the ocean. How these things came about does not matter to the present argument. That they were so is all that we want to know. Whether we had borrowed water from the Northern Hemisphere, and then lost it; or, whether the internal forces of the earth sank our land, and then raised it, is of no consequence. Indeed, great savans, as well as great preachers, allow of no obstacles to a favourite theory or belief. Thus, Lyell, to prove alternation of heat and cold, by the exercise of a little imagination puts Europe, Asia, Africa, and America, at the equator, and as quickly sets them at the poles; and Dr. Lang, of Sydney, to prove that the Polynesians and Americans descended from a common stock, lays dry the mighty and deep Pacific, and even Madagascar and New Zealand have been joined that the moas might have social intercourse.

Then, if the facts be admitted, even though the causes be unknown, we will have the mountains at near 3,000 feet less in elevation; Mount Cook, instead of towering 12,460 feet, would yet be majestic at 9,460; and the valleys of the Waitaki, Clutha, Taieri, etc., would be under the sea, and, in their upper portions, inlets thereof. At this epoch the dry land and shores would be covered with glaciers, the sea with icebergs, the temperature and constant attrition of which would allow no shell fish to exist. Hence their absence in the drifts.

Now, to form an idea of how the terraces are left on dry land in their present aspect, we must observe miniature operations of the present date; the principle being the same, the results of similar nature. If we take the shores of a lake, such as that of Wakatipu or Wanaka, or the banks of a large river, such as Molyneux or Waitaki, which are subject to periodical rises and falls,

and which, also, have numerous rivulets running into and joining them, we will have the examples required. Then observe the banks of the lake or river at full flood, and you will see no indications of terraces, unless under water. Above the flood-line, no doubt, will be seen the terraces of former ages, but within the limits of rise and fall of the lake or river itself is only to be seen the action, in miniature, which is of use in illustration. Then it is by receding waters, or waters that have receded, that the terraces became apparent—of a river or lake in a few months; of the great ocean in many centuries. Yet the action and results are precisely similar; for, looking at the conformation of the surface of the shores of a lake or river where the feeder, or rivulet, enters, you will see the slopes divided into terraces: highest near the flood marks, lowest near the low water; most inclined near the flood mark, least inclined near the low water; the largest particles or pebbles near the flood mark, mere sand or mud near the low water; thus conforming, in every respect, to the gigantic formations which we are now considering. And let two streams enter a lake or river closely adjoining—the spurs between will be the same—sloping with the opposite terraces, and the talus will reach out in the manner that the receding waters had tended. If this be the law in small areas, so it is in great. It is, therefore (after glacial action had filled up the valleys with *débris*), to the receding waters of the ocean, assisted by influx and reflux of tide, with the feeder from the mountains at the head, that we may, without fear of contradiction, ascribe the hollowing out of the gullies in the terraces, and the transport of the smaller gravel and sands towards the ocean shores. Thus, while the glaciers brought down the shingle and deposited it all over the valleys, the succeding action of scoring out the terraces themselves into gullies was effected by the land rising, or, in other words, the ocean receding.

And while we see the terrace formations most prominent in the interior, most inferior near the coast, this is also due to the interior ones having been protected from the ocean surf by the enclosing mountains, while those on the seaboard have been subject to the full force of this degrading power. The whole formation of terraces, as we now see them in Otago, therefore, we may reiterate, have been the result of the mechanical action of nature operating, first in the long period of the glacial age, then afterwards by the rise of land, in which the tides of a receding ocean and the fresh waters of the mountains together acted as moulders of the present forms in their bold fronts, long reaches, abrupt rises, deep indentations, and mathematically-curving slopes.

With the well-known fact before us, that gold is found disseminated in quartz veins, and reefs intersecting the schist rocks, of which the mountains of the interior are principally composed—a fact so intimately connected with one of the most important industrial pursuits—some allusion to it is called for. The allusion must necessarily be a mere passing one, as no justice can be done it

by one, such as myself, who has been but a mere occasional observer. Indeed, to pursue the enquiry with credit to oneself and advantage to the public, close application and very extended observation would be required for some years. All that I may therefore venture on is rather by way of suggestion than confirmed opinion.

If we admit that our auriferous mountains have been eroded to the depth of 600 feet, more or less, according to position—and this is a very moderate estimate—then will the gold particles have been submitted to the same action as we have seen other particles to be; and this principle will pervade, that the heavier will be found nearest the sources in the mountains; lighter, till they become impalpable dust, nearest the sea coast.

Practical gold miners will tell you that this is the fact. With a knowledge of this principle then, and indications of what was the trend of the glacial masses that caused the erosions and transport, these may give us a clue to follow up gold-bearing drifts to their sources, and so to the reefs. Further, glaciers are observed to grind down the softer constituents of the schist rocks to impalpable dust; this becomes deposited in beds by the action of water, and so forms, in time, a strong cementatious matter, which, with the larger particles of quartz, hornblende, chert, etc., became auriferous conglomerates. Where such a deposit is found with the shingle and gravel but little water-worn, then may we conclude that the original sources of the precious metal are not far off; for, if the sources were distant, the heavy shingle would not only have been well rounded, but the impalpable dust (imponderable in water) forming the concrete would have been dissipated and separated therefrom.

But there is another action that must have had considerable influence in the transport and deposit of gold, viz., icebergs or masses breaking off from the termini of the glaciers. These are known to bear large collections of rock and shingle, so, while they stranded along the terraces of the valleys or bars of the inlets, would they part with their burdens as they melted. The rocks and shingle would then disintegrate by the force of the waves or currents, and so part with the gold enclosed in them. It is by this action alone that I can see to account for the gold-bearing shingles of the shores of Southland and Molyneux, a distance so far from the mountains.

In regard to mountain glaciers, as contradistinguished from terrene glaciers, I need offer but few remarks, as they have been already fully and ably discussed in a paper (already mentioned) before this Society. What I have to offer are views taken from different aspects, such as they occurred to myself personally when visiting the localities at different times. The mountain glaciers, when viewed by themselves, are most stupendous in their dimensions and apparent effects; when viewed relatively with terrene glaciers their magnitude and influence are very circumscribed and diminutive. As the

snows of the mountains in this district show their influence in the last month of the year, by melting and flooding the torrents, so may the mountain glaciers be said to have a marked epoch, special to themselves, at the end of the glacial age, which epoch is recorded by the moraines now extending round or at their ancient lower termini. Speaking from recollection, and going back seventeen years, I was struck with the immense hillocks of confused rubble, earth, and boulders extending round the southern shores of Ohau to Pukaki, and rising near 300 feet in elevation. There was, now, no apparent cause for this until we turned our eyes to view the receding glaciers, to be descried in the distance, high up in the mountains. So, at the southern end of Lake Wakatipu, similar phenomena are to be observed, leading to the same conclusions. The Francis Joseph Glacier, on the West Coast, extends down to 700 feet from the sea level, and those on the eastern slopes of the Southern Alps to 2,774 feet. Thus, in a particular valley on the West Coast, the glacial age may be said to be only 700 feet perpendicularly distant; while, horizontally, it is, as stated before, 23 degrees of latitude southward. On comparing the measurements, it will be at once noted that those of the valleys of the Waitaki and the Clutha are much modified; this is owing to the Pukaki and Wanaka Lakes forming portions of the valleys of the Waitaki and Molyneux. The cause of this exception has been ascribed, by one class of observers, to the scooping effects of mountain glaciers, while, by another class, it has been ascribed to the original depressions when the mountains and valleys assumed the geological arrangement now existing. As much has been advanced on both sides of the question, I will content myself by suggesting that we will not be doing much violence to either theory by giving both of them weight in modelling the surface of our valleys to their present form. Thus, I may ask those gentlemen who adhere to this lake-scooping action alone, why the Ahuriri had not a lake as well as its neighbour the Ohau; the Shotover and Arrow as well as the Dart and Rees; and the Oreti as well as its neighbour the Mararora; all flowing out of glacial mountains and under similar conditions? May we not give weight to the axiom, that where there are high elevations, so must there be low depressions; and where one varies in height, so will the other in depth? Thus, may not the valley of the Wanaka have been originally lower than that of the Matukituki, as their respective passes are lower; and so, while the valley of one is filled with water, the other is filled with the bed rock, overlain with sand and shingle.

Then, to revert to the influence that glaciers of probably 3,000 and more feet in thickness would have in scooping action, or modification of shores and bottom, we must consider the nature of the rocks acted on.

The resisting power of the hard schists, being as hard as granite, that line the Wakatipu Lake, varies from 5,500lbs. to 11,000lbs. per square inch. Now,

the crushing power of ice 3,000 feet thick, as already stated, only amounts to 1,227lbs. per square inch; thus its effect would be slight by way of crushing, though there might be large erosions by the disruption of blocks and strata from their beds on the face of the mountains, where gravity would also lend its aid. Yet, in the valley beds, as there would not be this aid, it is difficult to assent to such great erosions as would be required for the whole scooping out of the lake areas by a power equal to 12 against a resistance equal to from 55 to 110. Hence a middle course between two opposite theories appears to me to be the correct one. Speaking of this geological era, the lake beds were there *ab initio*, though much modified, it may be deepened and widened by the action, originally of terrene, and latterly of mountain, glaciers. Thus we cannot give the same weight to glacial power, for erosion and transport of material in broad lake or valley beds composed of hard rock, as we can to the same power on the slopes of the mountains, or in narrow gorges, or on the soft tertiary formations of the coast, such as we have on the Waitaki Plains. As a support to this opinion I adduce a case known to you all, viz., the Water of Leith and Kaikorai. The former, having a much larger drainage area and steeper mountains around it, yet passing through hard trap rocks, has but a very narrow valley bed; while the latter, with a much smaller drainage area and low hills around it, yet passing through soft sandstone rocks, has a spacious valley bed. This is clearly due to the relative powers of erosion and and resistance; so it is with the most stupendous operations of physical geography.

I now come to the subject of alluvial formations—a subject more immediately connected with the welfare and existence of mankind than almost any other—as on these are the most fertile plains and densest populations. How glacial action and terrace formation have to do with these will not immediately appear, but I hope to show they do so intimately. For a proper understanding of the subject—or, in other words, to grasp at one view what are very prolonged and diffused operations of nature—I must invite you to look at what is now going on, under your eyes at this present time, in many parts of this Province. I allude to the gold miners' sluicing works, for by them we see in one day what nature commonly displays in a thousand years; and if, in relation to the forces, you will agree with me that one day is as a thousand years, so you will admit the aptness of the illustration.

The gold miner, in pursuing his avocations, sometimes has recourse to what is called sluicing—that is, washing down the auriferous strata from the hills into the plains—by which means he separates the gold from the gravel and earth. In doing this he performs, in miniature and in a few months' time, what glacial action did so extensively in the course of many ages—that is, out of the hills he creates new alluvial deposits in the plains; unfortunately, being

so hurriedly done, he does not at the same time, like nature, mix his earth with vegetable matter, and so replenish the plains with fertile soil capable of bearing fruit for the sustenance of man, but otherwise his sluicing avocations are the same in principle as glacial action.

Now if we watch sluicing operations from the commencement to their conclusion, we will see a parallel to one of the most benign provisions of nature most closely carried out. Let us take a hill-side bordering on a flat, such as at Gabriel Gully, or Weatherstone's; we will see that the shingle is deposited from the sluice nearest the hill; then the gravel; furthest off is carried the mud and silt. Thus, let A be the hill that is sluiced, and B the plain; first, the *tailings* are carried in the direction of AB, then, as the earth rises, the channel gets choked, so they are carried in the direction of *c*; this being filled up, then in the direction of *f*; then of *d*; then of *h*; then of *e*; and so forth; spreading out the material in the form of a fan, in separate layers, these layers varying with the quality of the soil taken out of the hill. Thus, if *z* were blue it would be spread in a thin layer over the portions of the fan it was carried to; if *y* were red it would be spread out at other parts in the same manner; and, if *x* were white it would appear at its proper time and in its proper layer, and this might be done over a thousand times.

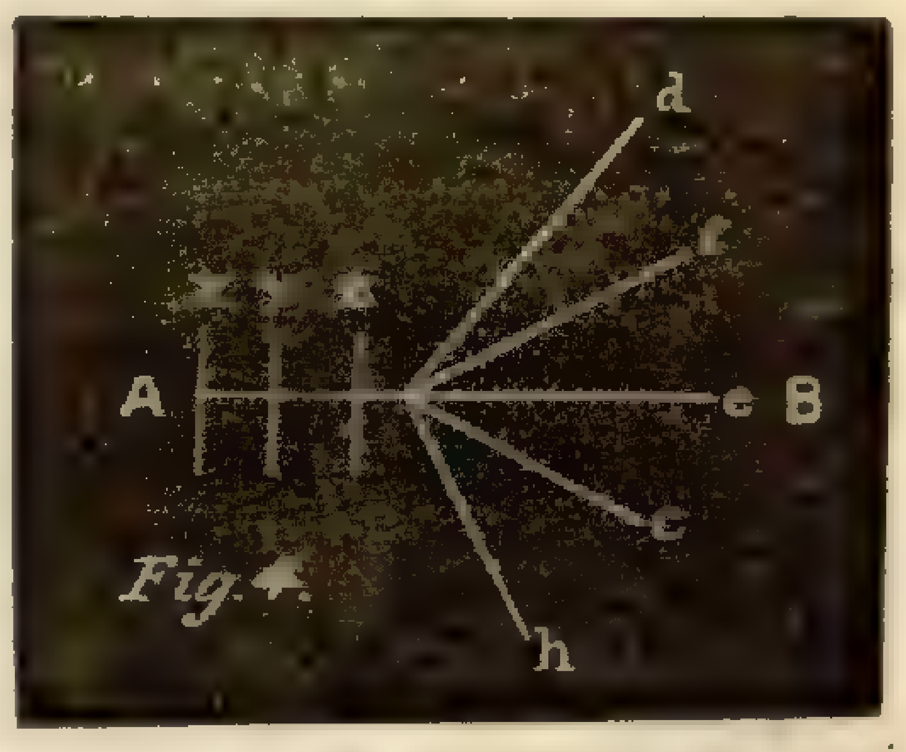

Fig. 4.

Thus the modern gold sluicer answers the enigma that puzzles the Taieri farmer, when he discovers trees so far below the present surface, by telling him that these trees grew at a time when the glacial sluicing operations were at *z*, and whose tailings were deposited far below those of *x* and *y*.

If such be the process by which the gold miner, in his sluicing operations, spreads out *débris*, drift, alluvial sludge, or tailings, in strata all over the plain, such we may anticipate is the precise process by which the same matter is made to cover the plains of New Zealand, wherein terrene and mountain glaciers perform the functions of the sluicer. And we have only to look to the neighbouring Province of Canterbury to see the effects of the process developed in its most prodigious grandeur. I allude to the fan-like deposits of the Rakaia, Rangitata, and Waimakariri, on the spacious plains of that part of the Middle Island. In Otago, except on the Waitaki, probably we have no such examples, though we have great numbers on a minor scale, which may be called lateral alluvials, brought out from the small gorges of the limestone ranges at Papakaio, Waikari, Kakanui, etc. But in all cases, whether the deposits have been the result of natural or artificial causes, whether great or small, they all appear to conform to one principle, and to adhere to one shape, vertically and horizontally.

This led me to enquire if there was a law of deposit, and, in going over all the surveys and levels to be obtained in this Province, I found that all were more or less deficient in completion, excepting the very careful survey of the Taieri Plain by Mr. Adam Johnston. Here the information was as complete in every respect as could be desired, though the extent of deposits are very small in comparison with those of the Canterbury rivers. However, the essentials were the same, viz., alluvial deposits spread out over a plain from a narrow gorge in mountains running parallel with the plain. Thus the deposits, as brought out, had free scope for extension over 180 degrees of the horizon, and the result is precisely that of what may be seen in the "tailings" of many of our gold workings. The Taieri, bearing the *dêbris* from mountain glaciers originally, and now that of floods, issues on the plain at Outram Bridge, and meets the low-water mark of the tide at Adams', a distance of 12½ miles measured by the sinuosities of the channel. The difference of level between the river, in its ordinary state, at Adams' and Outram Bridge, is 17·57 feet; and the levels of intermediate distances are given respectively, showing a curve of a very decided contour. The curve is neither that of the hyperbola nor circle. With the *data* given, and by the formula already used in given cases, it was compared by computation with the parabola, but found not to accord therewith. It was then tested by the properties of the ellipse, with the following result, so nearly approximating that it may be said to be one and the same:—

	By Ellipse.	By Survey.	Differences.
At Outram Bridge	00·00	00·00	0·00
At intermediate points ...	11·55	10·75	0·80
	14·12	13·26	0·86
	15·06	14·95	0·11
	17·12	16·78	0·34
At Adams' Accommodation House...	17·57	17·57	0·00

Thus, in this instance (and I have no doubt the agreement will be the same in all similar conditions of water scooping out the gravel, clay, and mud), water descending to its level, through alluvial soil, digs or scores out its bed to the curve of the ellipse; and thus, in a remarkable manner, imitates the semi-liquid glacier in its operations on the valleys of the earth.

This, then, is the law of erosion, but not of deposit, the next subject of enquiry. In searching for a law of deposit we again refer to Mr. Johnston's survey, which gives us ample *data*. Taking his levels between the same points, we find the distance by flood-channel 59,730 feet, or about 11 miles; and the difference of level 30 feet. Levels are also given at intermediate points, resulting in a decided curve. In this case the summit of the alluvial banks are taken, the effect of many floods, and not of one in particular; as Mr. Johnston's map elicits the curious fact that separate floods have very

unconforming levels at different parts of their courses. This curve of deposit, as I may call it, was first tested by the properties of the ellipse, but found not to accord; it was then tested by the parabola, with the following results:—

	BY PARABOLA.	BY SURVEY.	DIFFERENCES.
At Outram Bridge	00·0	00·0	0·0
At intermediate points	13·3	14·4	1·1
	19·1	19·5	0·4
	23·2	22·7	0·5
	25·7	26·1	0·4
At Adams' Accommodation House	30·0	30·0	0·0

Thus, the curve of deposit may be said to be identical with the parabola, varying from it, in a course of eleven miles, on an average of six-tenths of a foot. The theoretic course of a cannon ball is in a curve of the parabola, subject, as it is, to unequal resistance and deflection of the atmosphere and its currents; it, in practice, does not excel water in its mathematical truth, as here displayed.

Here, then, are two laws proved in the Taieri "tailings," as the gold digger would term them. The law of scooping out is as the ellipse; that of spreading out as the parabola. And what practical objects do these lead us to. Many, no doubt, will develop themselves in various minds; one or two I may shortly state.

The first is one of geological interest. When the plains were being covered by detritus to the parabolic curve, glacial action was, of necessity, in full force. The valleys were filled with moving ice and turbid water, grinding against the sides and bottom of the earth. At the time this was in process the torrents issuing on the plains would have no more certain beds than the sluice waters of the miner, but would diverge to and flow over 180° of the horizon, depositing its "sludge" where there was readiest outlet or lowest level.

But as the cycle pursued its course, so, with the increase of temperature, the ice of the glaciers would melt or retreat in diminished bulk to the tops of the valleys; then the depositing power would virtually cease, and the opposite, or eroding action, by the torrents finding for themselves a confined channel, would take place. Thus we arrive at the present era. As it is with great, so it is with small, things. No sooner are the miners' claims worked out than deposits, spread out in the parabolic curve, cease, and the clear water, now unused, seeks for itself a confined channel in the elliptic curve.

The other question may be called an engineering one. If detritus is deposited as the parabola, and scooped out as the ellipse, then we may conclude that such rivers as the Waitaki, on whose outlet the sea is encroaching, will more and more adhere to a confined channel—the elliptic curve following a lower course than the parabola; but that such rivers as the Waimakariri,

Wairarapa, and Oreti, whose outlets are advancing on the sea, being into deep bays with shallow waters, will tend intermittently to diverge from their channels. Hence, if the theory prove a correct one, there might be some utility in the careful investigation of the curves of these rivers in regard to their ordinary flood and glacial drift marks, *i.e.*, their highest banks, which would clearly display the points where the two first tend, in any measure, to overflow the latter.* It is certain as noonday that nature always works by law, and there can be no waste of human energy when it is expended in the investigation of the course that law pursues.

In conclusion, I may venture to state that the more we study these subjects the more we will be convinced that nature as much abhors cataclysms and sudden catastrophes as she is said to abhor a vacuum. Her changes are gradual, and her operations, in changing from latitude to latitude, present themselves to us merely as accelerations in one zone and retardations in another. Thus, if the scoring out of the valleys by glaciers is in full force in Victoria Land at the present day, such action, to all intents, has ceased here. That the ceasing has been gradual, prolonged over hundreds of thousands of years, I think will be a generally-received opinion; so, also, will this be accepted, that the commencing of the glacial age, with its prodigious overflowing and deadening influences, was also as prolonged. To living creatures the change would come on so slowly as to be harmless and unobservable, and what may now be the tendency of our climate could only be indicated by rigidly scientific observations continued over a century.

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* Drainage and embanking operations will be under the same law, also the cutting of sludge channels in mining. Here embankments should be as the parabola; drains and channel beds as the ellipse. In large works the money saved would be enormous by the adherence to correct principle.

ART. LII.—*On the Fossil Reptilia of New Zealand.* By JAMES HECTOR, M.D., F.R.S., Director of the Geological Survey of New Zealand.

Plates XXVII.—XXXI.

[*Read before the Wellington Philosophical Society*, 13*th October*, 1873.]

THE first notice of the occurrence in New Zealand strata of representatives of the Reptilian fauna characteristic of the mesozoic epoch, was made in 1861, when Professor Owen communicated to the British Association a brief description of certain fossils that had been discovered by Mr. T. H. Cockburn Hood, F.G.S., and presented by him to the British Museum. These fossil remains were obtained by Mr. Hood in a ravine on one of the tributaries of the Waipara River, at the northern extremity of the Canterbury plains. They comprise the vertebral centra, ribs, and coracoid bones, all belonging to the same individual which Professor Owen referred to a new species—*Plesiosaurus australis*.*

No further discovery of Saurian remains was made till after the occurrence of a great flood, in 1868, when Mr. Hood again obtained a large collection, and shipped it to England, unfortunately, by the ship "Mataoka," which was lost on the homeward voyage. Dr. Haast, however, communicated a short account of this collection to the Philosophical Institute of Canterbury,† and states that he "made drawings and took measurements of all the more important specimens, so that, in case the collection should not reach its destination, the information, at least, will not be altogether lost to the scientific world." This foresight was most fortunate, as, notwithstanding the great number and variety of the remains since found, that collection appears to have contained the only skull fragment, with jaws and teeth, of a true Sauropterygian that has yet been discovered.

In 1867 I had visited the locality‡ along with Mr. W. T. L. Travers, and obtained only a few fragments of these fossils; but after Mr. Hood's second discovery I sent Mr. R. L. Holmes, provided with the requisite appliances, to obtain a more complete collection for the Colonial Museum. Drawings of these, forwarded to Professor Owen, enabled him to add two new species, which he named *Plesiosaurus crassicostatus* and *P. hoodii*.§

In the following year Dr. Haast made a detailed survey of the district, and obtained a large series of Saurian and other fossils, which are now in the Canterbury Museum.‖

Mr. John Buchanan, of the Geological Survey Department, having some years previously discovered the existence of Belemnite beds at the Amuri Bluff, a locality on the East Coast fifty miles north of the Waipara,¶ Dr. Haast's

* Trans. Brit. Ass., 1861, p. 122, *et seq.* † Trans. N.Z. Inst., Vol. II., p. 186.
‡ Prog. Rep. Geol. Surv. N.Z., 1868, p. 9.
§ Geol. Mag., Feb., 1870, Vol. VII., p. 49, pl. 3. ‖ Rep. Geol. Surv. N.Z., 1870, p. 5.
¶ Geol. Rep., 1867.

survey was extended in that direction in the summer of 1869, and resulted in finding several localities extremely rich in Reptilian remains. These are described in his report,* and his collections, having been forwarded to the Colonial Museum, form part of the material of the present communication.

In 1871, Mr. H. H. Travers made a further exploration at the Amuri Bluff; and during the early part of this year the relations of the different formations have been studied by Captain Hutton†; and a skilled collector, Mr. Alexander McKay, has also been employed to make an exhaustive collection of the Reptilian remains and associated fossils.

These different explorations have led to the accumulation of several tons of blocks of cement-stone containing fossil bones, and during the last three months these fossils have been worked out of the hard matrix by Mr. McKay. The general result is, that portions of 43 individual reptiles, mostly of gigantic size and all of aquatic habits, and belonging to at least 13 distinct species, have been discovered. These species represent two distinct groups, the first, with flat or slightly bi-concave vertebræ, being true Enaliosaurians, belonging to the genera *Plesiosaurus*, *Mauisaurus*,‡ (gen. nov. allied to *Elasmosaurus* of Cope), and *Polycotylus*, Cope ; and the other having procœlian vertebræ, as in most recent Lacertilia and Crocodiles, but provided with swimming paddles, and therefore representing probably the order Pythonomorpha of Professor Cope.§ This order is represented in the collection by two distinct genera, *Liodon* (Owen), and *Taniwhasaurus*,|| (gen. nov. allied to *Clidastes* of Cope).

In addition there are several fragmentary remains, which, for the present, I only venture to place provisionally under one or other of these groups, and two vertebræ, which appear to belong to an exceptional form of the genus *Crocodilus*.

Lastly, from the lower mesozoic strata of Mount Potts, in Canterbury, a single vertebra was collected by Dr. Haast,¶ which I refer to the genus *Ichthyosaurus*.

The following is a schedule of the different Saurian remains referred to in this paper, with the localities where they were found, and the names of the collectors. When not otherwise stated the specimens are in the Colonial Museum at Wellington :—

* Rep. Geol. Surv. N.Z., 1870–71, p. 25.

† Geol. Rep., 1872–73, p. 36.

‡ After *Maui*, the traditional discoverer of New Zealand.

§ "On the Fossil Reptilia of the Cretaceous Rocks of Kansas," by Professor E. D. Cope. Preliminary Rep. on Geol. of Wyoming, F. V. Hayden, 1871, p. 385. I have not been able to refer to the original paper, by Professor Cope, in the Trans. Amer. Phil. Soc., 1868–70, for the definition of this order.

|| After the *Taniwha*, or fabled sea monster of the Maori.

¶ Rep. Geol. Surv., 1873, p. 6.

No.	Name.	Nature of Specimen.	Collector.	Amuri.	Cheviot.	Waipara
1	*Plesiosaurus australis* (Owen)	*a.* Vertebræ and extremities (in British Museum)	Hood			*
		b. Posterior trunk and limbs	McKay	*		
		c. Trunk (in Canterbury Museum)	Haast			*
		d. Vertebral centrum	Haast		*	
2	*Plesiosaurus crassicostatus* (Owen)	*a.* Thorax, neck, and humerus	Holmes			*
		b. Humerus and ribs	McKay	*		
		c. Cervical vertebræ	Haast	*		
		d. Vertebræ, coracoid, and humerus (in Canterbury Museum)	Haast			*
3	*Plesiosaurus hoodii* (Owen)	*a.* Cervical vertebra	Holmes			*
		b. Three vertebræ	Holmes			*
		c. Three vertebræ	McKay	*		
		d. Vertebra and thirty connected phalanges	McKay	*		
4	*Plesiosaurus holmesii*, n. sp.	*a.* Eleven lumbar vertebræ	Holmes			*
		b. Coracoid and part of humerus	Holmes			*
		c. Part of humerus	Holmes			*
		d. Humerus	McKay	*		
		e. Vertebra	Haast	*		
		f. Vertebræ (in Canterbury Museum)	Haast			*
5	*Plesiosaurus traversii*, n. sp.	*a.* Nine vertebræ	H. Travers	*		
		b. Four vertebræ and teeth	McKay	*		
		c. Four vertebræ and chevron bones	Haast	*		
6	*Plesiosaurus mackayii*, n. sp.	*a.* Three vertebræ, part of coracoids, humerus, and clavicle	McKay	*		
		b. Paddle bone (in Canterbury Museum)	Haast	*		
7	*Polycotylus tenuis*, n. sp.	*a.* Vertebral centrum and humeri	McKay	*		
		b. Vertebræ and limbs	McKay	*		
		c. Vertebra and pelvic arch	McKay	*		
		d. Pelvic bone	Haast	*		

No.	Name.	Nature of Specimen.	Collector.	Amuri.	Cheviot.	Waipara
8	*Mauisaurus haastii*, n. sp.	*a.* Coracoids, scapula, and paddles	Haast		*	
		b. Four vertebræ, ribs, humerus, and paddles	H. Travers	*		
		c. Vertebra	H. Travers	*		
		d. Paddle	McKay	*		
		e. Four Vertebræ	Haast	*		
		f. Thirteen cervical vertebræ	H. Travers	*		
		g. Vertebra (in Canterbury Museum)	Haast			*
		h. Cast of jaw fragment and teeth (?)	W. Travers			*
9	*Mauisaurus brachiolatus*, n. sp.	*a.* Humerus	Haast	*		
		b. Humerus and other paddle bones (Canterbury Museum)	Haast			* ?
10	*Liodon haumuriensis*, n. sp.	*a.* Jaws with teeth	McKay	*		
		b. Caudal vertebræ and chevron bones	McKay	*		
		c. Eight cervical vertebræ	McKay	*		
		d. Ten lumbar vertebræ and ribs	Holmes			*
		e. Seven true ribs, also abdominal ribs and phalanges	Holmes			*
		f. Caudal vertebræ	Haast	*		
		g. Lower jaws, with teeth	Haast	*		
		h. Jaws and vertebræ	McKay	*		
		i. Vertebræ, etc. (in Canterbury Museum)	Haast			*
11	*Taniwhasaurus oweni*, n. sp.	*a.* Lumbar vertebræ, spines, and ribs	H. Travers	*		
		b. Paddle and pelvic bone	H. Travers	*		
		c. Head, lower jaw, and teeth	H. Travers	*		
		d. Jaws and teeth, with fragments	Haast	*		
		e. Pelvic and paddle bones, and ribs	McKay	*		
		f. Three vertebræ	McKay	*		
		g. Vertebra	Haast	*		
12	*Crocodilus ?*	*a.* Cervical and dorsal vertebræ	McKay	*		
13	*Ichthyosaurus australis*, n. sp.	*a.* One vertebral centrum	Haast	Mt. Potts (triassic)		

Not having examined the Amuri district, where the best sections of the formation containing Reptilian remains are exposed, I will not, at present, discuss their stratigraphical position, but refer to the reports of Dr. Haast and Captain Hutton, already quoted. That they belong to the upper part of the mesozoic period, representing the horizon of the cretaceous period of Europe, is rendered pretty certain by the associated fossils, which belong to the following genera :—

Ammonites, Scaphites, Nautilus, Belemnites (three species).

Turbo, Neptunœa, Aporrhais, Conchothyra, Scalaria, Natica, Pleurotoma, Dentalium.

Terebratula.

Panopœa, Cytherea, Lucina, Eriphylla, Protocardium, Crassatella, Astarte, Crenella, Myacites? Trigonia (three species), *Cucullœa, Axinœa, Leda, Pecten, Radula, Plagiostoma, Inoceramus* (four species), *Mytilus, Chama, Gryphœa, Ostrea, Aucella.*

Teredo, Pentacrinus, Corallines, *Foraminifera*, fish teeth and scales.

With the view of assisting collectors in determining the portions of Reptilian remains which are most likely to be found, I offer the following artificial diognoses of the genera in which they have been provisionally placed:—

SAUROPTERYGIA.

Vertebræ with both ends flat, or concave.

Teeth curved, with striated, sharp-pointed crowns; are found in the rock matrix free from the jaws.

A—PLESIOSAURUS.

Centrum of dorsal vertebræ short as compared with its width, which is greater than its height; flat, or only slightly concave at both ends. Humerus prismatic, with a round proximal surface; distal end expanded and flat.

B—POLYCOTYLUS.

Centrum of dorsal vertebræ nearly equal in length to its diameter, constricted, articular surfaces circular, concave, with an elongated tubercle in the centre of the depression. Humerus slender and long in proportion to the size of the vertebræ, with two articular facets on the proximal end.

C—MAUISAURUS.

Centrum of dorsal vertebræ equal in length to the diameter, with smooth, concave sides, and an inferior mesial ridge; articular facets circular, flat, with a deep pit in the centre. Humerus with a large tuberosity.

D—ICHTHYOSAURUS.

Vertebræ consist of deeply biconcave disks.

PYTHONOMORPHA.

Vertebræ concave in front, and convex behind. Teeth firmly attached to the jaw ; never occur free in the matrix, except when broken off.

A—Liodon.

Dorsal vertebræ subprismatic, cup and ball of equal diameter. Teeth conical, curved, with thick enamel, pulp cavity constricted at base.

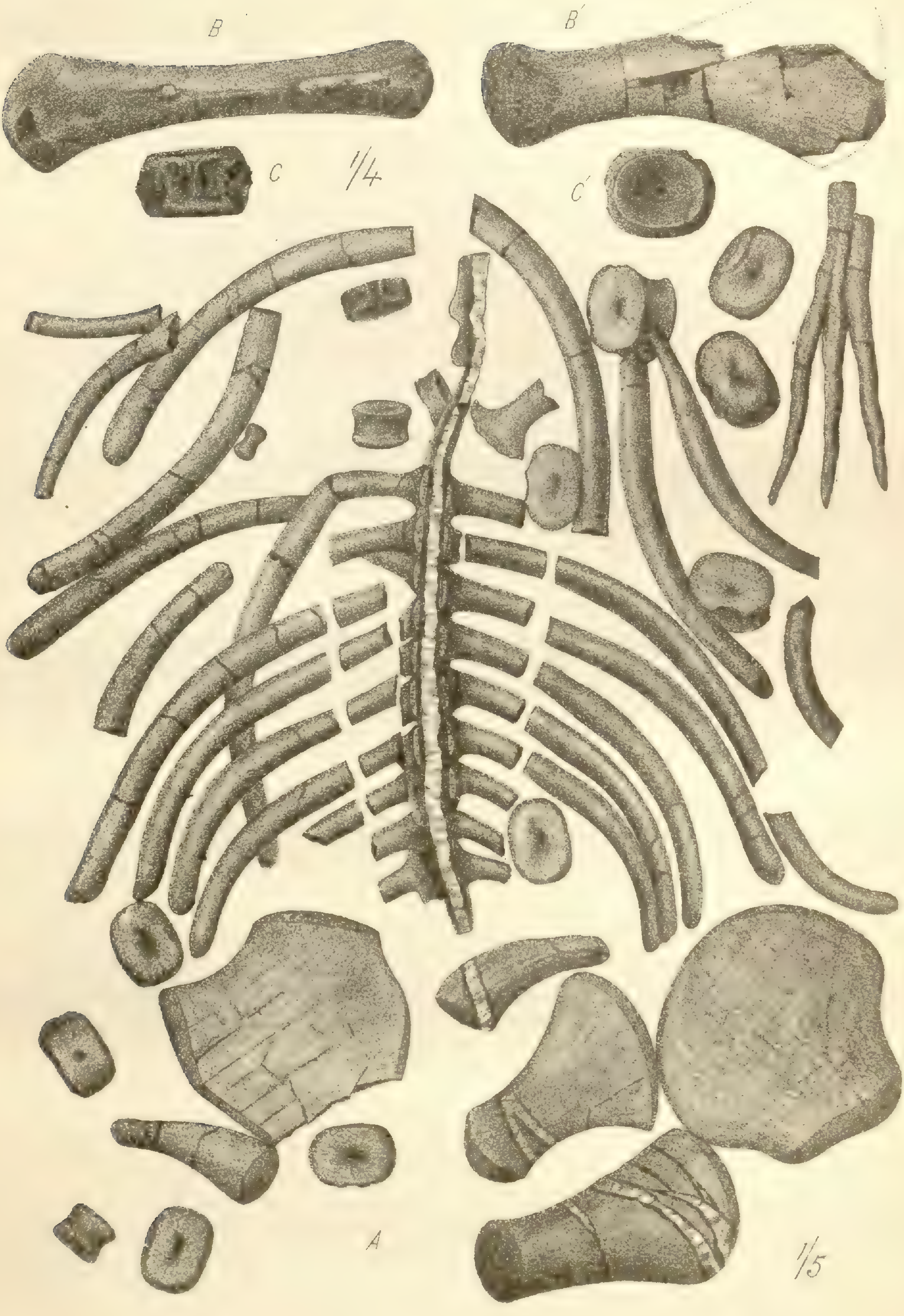
B—Taniwhasaurus.

Dorsal vertebræ with the cup end expanded, and tapering obliquely to the ball end. Humerus very short, wide, and with powerful muscular crests. Teeth conical, with pulp cavity expanded at base.

1. Plesiosaurus australis, Owen. Proc. Brit. Assoc., 1861, p. 122.

As Professor Owen's description of the specimens on which he founded this species is not accessible to many in the colony, I quote it at length.

The specimens "consisted of two vertebral bodies or centrums, ribs, and portions of the two coracoids of the same individual, all in the usual petrified condition of oolitic fossils. Their matrix was a bluish-grey clay-stone, effervescing with acid ; the largest mass contained impressions of parts of the arch, and of the transverse processes of nine dorsal vertebræ, and of ten ribs of the right side. Portions of five of the right diapophyses and of six of the ribs remained in this matrix. The bones had a ferruginous tint, contrasting with the matrix, as is commonly the case with specimens imbedded in the Oxfordian or liassic clays. The impression of the first diapophysis and of its rib, show the latter to have been articulated by a simple head to its extremity, as in the Plesiosaurus ; but the succeeding rib had been pushed a little behind the end of its diapophysis, and the same kind of dislocation had placed the five following ribs with their articular ends opposite the interspaces of their diapophyses. The ninth rib had nearly resumed its proper position opposite the end of the diapophysis, but at some distance from it ; the impression of the tenth rib shows the normal relative position of the pleur- and diapophyses. The ribs are solid, of compact texture, cylindrical, slightly curved, the fragments looking more like coprolites than bone ; they are about an inch in diameter, with but small intervals of, say, one-third of an inch, slightly expanding as they recede from the transverse process, and slightly contracting to the lower end. The first, terminating in an obtuse end of ½ an inch diameter, is 7 inches long ; the second is 8 inches long ; the third is 8½ inches ; the fourth rib is 9 inches long. The extremities of the others are broken off with the matrix. The separated fossils sent from New Zealand included the mesial coadjusted ends of a pair of long and broad bones, thickest where they were united, and



J. B. del. et lith.

A. PLESIOSAURUS AUSTRALIS.

B. B′. C. C′. POLYCOTYLUS TENUIS. *n. sp.*

becoming thinner as they extended outwards, and also towards the fore and hind parts of the bone, both of which ends were broken away. On one side the surface of the bone is convex lengthwise, and slightly concave transversely. On the opposite side the contour undulates lengthwise, the surface being concave, then rising to a convexity, where a protuberance has been formed by part of the coadjusted mesial margins of the bone; transversely this surface is slightly concave. A similar, but less developed, median prominence is seen at the middle of the medially united margins of the coracoids in the *Plesiosaurus hawkinsii*, and the author regards the above described parts of the New Zealand fossils as being homologous bones. But a more decided evidence of the Plesiosaurian nature of this antipodeal fossil is afforded by the vertebral centrums. They have flat articular ends, with two large and two small venous foramina beneath. The neurapophysial surfaces, showing the persistent independence of the neural arch, are separated from the costal surfaces by about half the diameter of the latter. These are of a full oval figure, 1 inch 3 lines in vertical, and 1 inch in fore-and-aft, diameter. On one side of one of the centrums the rib has coalesced with the costal surface. The following are the dimensions of this centrum:—Length 1 inch 9 lines, depth 2 inches 2 lines, breadth of articular end 3 inches 6 lines. The non-articular part of the centrum offers a fine silky character."*

To this same species I refer the specimens marked No. 1 *b* and *d* in the collection of the Colonial Museum.

No. 1 *b*.—This consists of the thoracic segment of the trunk of a young individual. The dorsal surface of the animal has been worked out of the hard matrix of the slab so as to expose ten posterior dorsal segments with ribs. No vertebral centra are exposed *in situ*, but scattered on the slab among the ribs are four belonging to the dorsal region, and about twelve to the caudal, together with the smaller bones of the paddles. The thoracic ribs, a few abdominal ribs, and the dislocated bones of the pelvic arch and appendages, complete the specimen, which measures 2 feet square. The matrix is the usual grey cement stone, containing an excess of lime, which is crystallized out in cracks, the vertebræ, for instance, being split through the neural spines by a thick vein of calcspar that traverses the entire length of the column, and is continued so as to intersect the femur of the right side. The neural spines project 1·5 inches above the transverse processes. They have rounded tips, are 1·3 inches in antero-posterior width, with zygapophyses projecting ·4 inch. The transverse processes are 1·7 inches long, cylindrical, and of the same size as the ribs, to which they are attached without any expanded facet, either on the process or the head of the rib.

The ribs, which are directed backwards on the spine as they lie in the

* Owen, Proceedings of Brit. Assoc., 1861, p. 122.

specimen, are cylindrical, the most anterior being the largest, viz., 9 inches in length by ·8 inch in diameter. They are closely packed, and, from their irregular curvature, seem as if they had been soft and flexible at the time they were imbedded in the calcareous mud. The largest caudal centrum has its transverse diameter 2 inches, and its vertical diameter 1·5 inches. The articular surfaces are nearly flat, with obtuse margins, and a distinct central pit. Their antero-posterior length is ·8 inch, with a single inferior venous foramen. Similar centra occur, of various sizes down to ·7 inch transverse diameter. None of the vertebral centra have attached processes, but some have distinct pits, to which the neural arch had its attachment. The dorsal centra are slightly longer, being 1·3 inches, and have a distinctly constricted form, their articular surfaces being a full oval, 2·3 inches by 1·6 inches, with sharp edges. On the ventral surface are two pairs of small foramina. The abdominal ribs are irregular in shape, tapering to both ends, and bound together, in groups of two or three, by their middle. Their greatest length is 10 inches.

The femur is 7 inches in length, proximal end rounded, 2·5 inches in diameter, distal end flattened and expanded to 4·5 inches. The pubic bone is rhomboidal, slightly concave, 6 × 6 inches, with only one well-marked elongated articular margin 3·5 inches in length. The ischium, of which only one is present, is more concave on the inner than the exposed surface, 2 inches wide at the articular extremity, 4·5 inches at the mesial, and 6 inches in length. The ilium has an irregular conical form, tapering, and slightly curved; its length is 4 inches, and its articular end, which is convex, is 2 inches in diameter. The paddle bones are flat, with slightly concave surfaces, and irregular outline. The phalanges are cylindrical, and much constricted in the middle.

Although the dimensions differ from those of the bones described by Professor Owen, which are common to the two specimens when allowance is made for the immature condition of the Amuri specimen, there is sufficient evidence to warrant their being placed in the same species. The characters on which I place most reliance are the coprolite-like form of the ribs and the silky texture.

No. 1 *d* is a vertebra found by Dr. Haast in a soft clay matrix, at the Cheviot Hills, along with the paddle of *Mauisaurus* (8 *a*), but is placed here on account of its remarkably Plesiosauroid character, the neural arch showing a distinct suture, though perfectly anchylosed to the centrum. This suture divides the articular surface for the head of the rib into two rough facets, the upper on a short transverse process, and the lower on the side of the centrum. The proportional length of the centrum of this vertebra exceeds that of any other Plesiosauroid in the collection, as will be seen from the following

dimensions:—Antero-posterior length 2·7 inches, transverse diameter 3·2 inches, vertical 2·8 inches, diameter of neural canal ·75 inch.

No. 1 *c.*—To this same species Dr. Haast has referred a fine specimen, which is exhibited in the Canterbury Museum, obtained at Boby's Creek, at Waipara. It is only partially worked out from the matrix, but shows the ventral aspect of the greater part of the trunk and tail of a Plesiosaur that measured probably 10 feet in length, the distance between the anterior margin of the thorax and the pubic arch being 4 feet. The portions of the skeleton which are visible are thirty-five vertebræ belonging to the dorsal and caudal regions, the scapula and pelvic arches, with appendages, and both vertebral and abdominal ribs. The transverse diameter of the vertebral centra is 2·15 inches, being greater than the vertical, while the length is only 1·7 inches. The height of the neural spines and the length of the transverse processes is about equal to the height of the vertebral centrum in the middle part of the back. The caudal vertebræ diminish rapidly in diameter and length towards the extremity of the tail. The coracoids form a very wide, compressed, bony plate, not much longer than the width in the middle, but constricted posteriorly, their length being equal to about six thoracic vertebræ. The ribs are slightly compressed, and do not agree well with Professor Owen's description of the type of the species to which this has been referred. The form of the vertebral centrum also exhibits so marked a difference in the proportion of the transverse diameter to the length, as to lead to the belief that it must have been a very different animal; but until it has been more clearly worked out from the matrix this cannot be well decided.

2. PLESIOSAURUS CRASSICOSTATUS, Owen. Geol. Mag., 1870, p. 52.

No. 2 *a.*—This fine slab, collected by Mr. R. L. Holmes at Boby's Creek, Waipara, exhibits the left side of the thorax and neck of a well-grown animal. A fullsized drawing of the specimen sent to Professor Owen enabled him to name this species; but, as the bones have since been more completely worked out from the matrix, and three dorsal centra discovered and extracted from beneath the ribs, I am able to add some further particulars regarding this interesting specimen.

Professor Owen remarks:—"Whoever may glance at a specimen or figure of a similarly-preserved trunk of a *Plesiosaurus* will appreciate the generic character of the ribs in the New Zealand fossil. They are robust, subcircular in section, expanding somewhat, or thickening, at their middle, obliterating there or leaving very little of intercostal space, at least in the collapsed condition of the chest. They are likewise solid."

The portion of the neck which has been preserved consists of seven cervical centra, each 1·4 inches in length, with 2·5 inches transverse, and 1·3 inches vertical

diameter. They are deeply excavated beneath, with two venous foramina. The articular surfaces are elongated transversely, forming a constricted oval, and only moderately concave, with rounded margins. The dorsal centra are more circular in form, the transverse and vertical diameters being 3·5 and 2·8 inches respectively, while the length is nearly 2 inches. They are much constricted on each side, and expanded at the ends to form a smooth, slightly concave articular surface, with a central tubercle ·5 inch in diameter. The neural processes are detached, their height, including the neural canal, being 4·5 inches. The lateral processes are flattened, but expanded at the tip, to form roughened circular facets for the rib articulations. Their length is 3·5, and width 1·3, inches. The ribs, twelve in number, are well preserved. They are flattened, with sharp anterior margins, slightly expanded towards the vertebral column, then constricted, and flattening out again at the centre, where they make an obtuse forward angle. The length of the first rib preserved is 12 inches, and of the eighth, which is the largest, 19 inches. The total length of the specimen is 3 feet, and, judging from the proportional length of the thorax in the long-necked Plesiosaurs, must have belonged to an animal at least 10 feet in length.

A portion of a humerus, belonging to this specimen, was also described (from a drawing) by Professor Owen, who points out that "it shows the hemispheroid articular head, coarsely pitted by characteristic circular depressions, with slightly raised margins. The degree of contraction of the shaft to the broken, and the indicated retention of a subcylindrical shape of shaft, are incompatible with any known modification of an Ichthyosaurian humerus or femur. These are more angular and transversely oblong at the proximal end, and more rapidly compressed and expanded in the distal one, in the fish-like sea-lizard. The fragment of limb bone in the Museum at Wellington is plainly Plesiosaurian. The long diameter of the head of the bone is 3·5 inches, the short diameter 3 inches. The peripheral contour is flatter or less convex on one side than the other, as it is in the same part of the femur of *Pleiosaurus portlandicus*, in which the small crateriform pits of the articular surface are shown; but their character is common to *Pleio-* and *Plesiosaurus*."

No. 2 *b* is a slab showing a humerus and a few broken ribs, identical with the above in their characters, obtained at the Amuri Bluff.

No. 2 *c* shows a few cervical vertebræ obtained by Dr. Haast at the same locality, which serve to confirm the occurrence of this species at both these localities.

No. 2 *d*, in the Canterbury Museum, are a few vertebræ, a coracoid bone, and humerus, from the Waipara, which also belong to this species.

3. PLESIOSAURUS HOODII, Owen. Geol. Mag., 1870, p. 51.

Professor Owen named this species from the drawing of a single cervical vertebra (3 *d*) obtained by Mr. Holmes at Waipara. These vertebræ, of which several other specimens have since been obtained (both from the Waipara, 3 *b*, and the Amuri Bluff, 3 *c* and 3 *d*), are easily distinguished by their peculiar characters, which are thus described, from the first discovered specimen, by Professor Owen :—" It is broad and flat on the under surface of the centrum ; the sides also of which, between the terminal articular surface, are more flattened than usual, and converge towards the neural surface, giving somewhat of a triangular figure to the vertical transverse section of that part. The pleurapophyses come off from the lower part of the sides, and are confluent therewith, like transverse processes. The characteristic pair of venous foramina open upon the middle of the under surface. This vertebra most resembles one from the bone bed of Aust-Cliff, near Bristol, described in my ' Report on British Fossil Reptiles,' 1839, p. 78, and referred, with a note of interrogation, to the *Plesiosaurus trigonus* of Cuvier. The articular surface of the centrum is moderately concave, with a transversely oblong depression in the centre, and the margin rounded off. The neural arch is anchylosed to the centrum. The neural canal is contracted, as usual in cold-blooded air-breathers, and shows the ordinary proportion of that in *Plesiosaurus.* The pleurapophyses are short and thick ; the fore and aft diameter of their base equals two-fifths of that of the entire centrum ; they are somewhat inclined downward. A distance of twice their vertical basal diameter intervenes between them and the anchylosed base of the neurapophysis.

"This vertebra gives the following dimensions :—

Length of centrum	2	inches	1	line.
Breadth of articular end of centrum ...	2	,,	2	,,
Height of articular end of centrum, at middle	1	,,	7	,,

"The New Zealand specimen shows an exceptional form among the extensive series of modified Plesiosaurian cervical vertebræ already defined or recognized. Moreover, it is that form which hitherto, from British deposits, has not been met with associated with other parts of the frame, yielding the characters of proportionate length of neck ; proportion of head to body ; shape and number of teeth ; form, structure, and proportions of limb-skeletons, either in relation to the trunk, or in that of the pectoral pair to the pelvic pair. In short, materials have been wanting for assurance that the degree of modification of the cervical vertebra may not have been associated with so much modification of the rest of the skeleton, as to warrant a generic section of *Sauropterygia*, or a subgeneric one in the Plesiosaurian family."

The proportions of the specimen given above agree well with the cervical vertebræ since obtained, although the actual dimensions vary somewhat. Thus,

in specimen 3 *c*, the length of the centrum is 2 inches, while the transverse and vertical diameter are 3 inches and 2·3 inches respectively. In specimen 3 *d* a posterior dorsal vertebra, without the neural spine, is recognized as belonging to this species, by the transversely elongated tubercle and the character of the articular facet. One end of the centrum has been broken off, so that its length cannot be ascertained, but it measures transversely 4 inches, and vertically 3·3 inches. The lateral processes spring from the side of the centrum, and not from the inferior third, as in the cervical vertebræ; and the neural spine, though broken off, has been distinctly continuous without any suture. This fusion of the neural arch, both in the anterior and posterior parts of the column thus indicated, confirms the suspicion that this species should be placed in a genus distinct from *Plesiosaurus*. On the same slab with this vertebra are thirty-two phalanges, exposed in their natural position in continuous rows; the largest about 2·7 inches in length, cylindrical, and only moderately constricted at the middle.

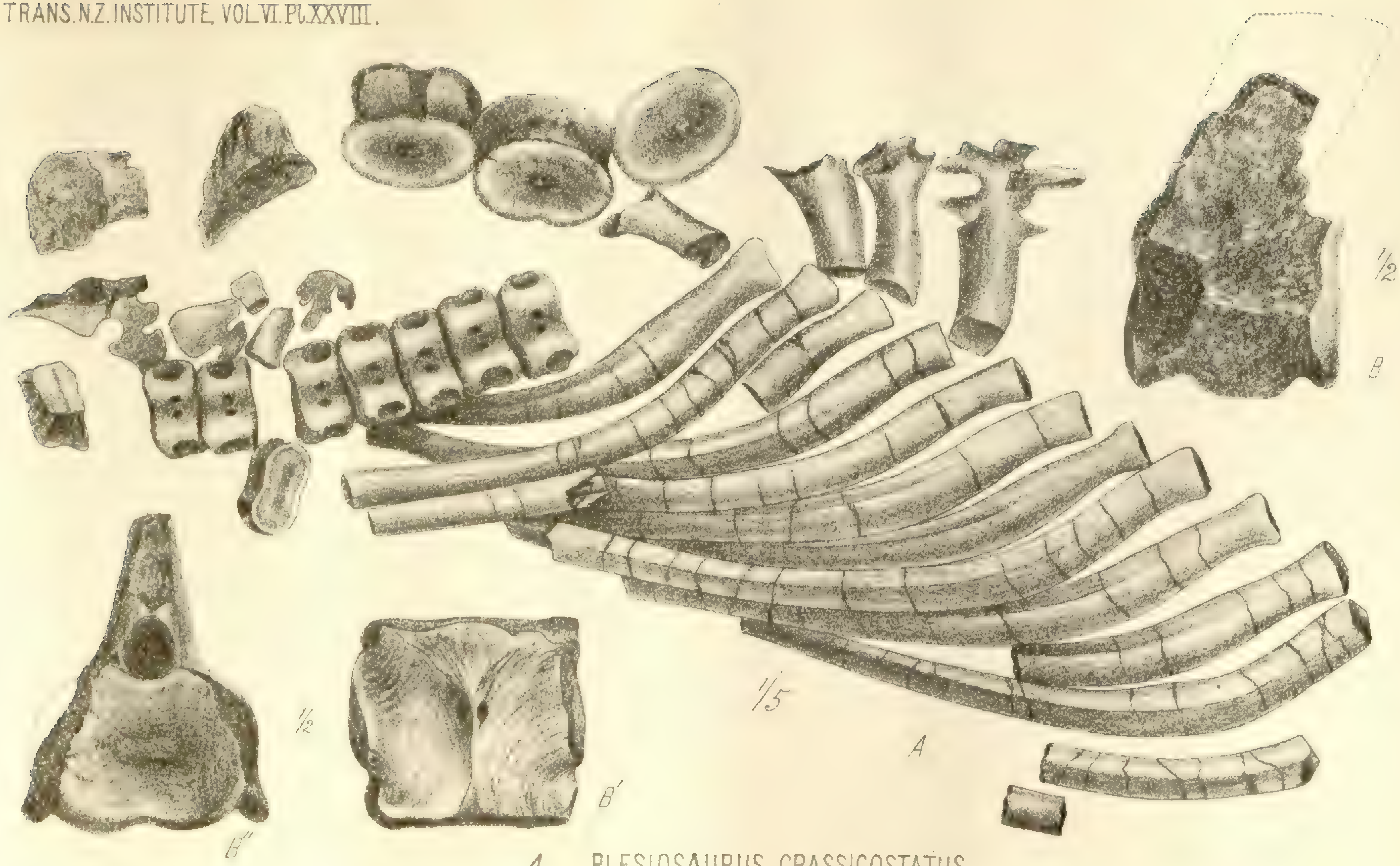
4. Plesiosaurus holmesii, n. sp.

This species is allied to *P. hoodii*, in the trigonal form of the vertebral centrum and the strong wedge-shaped neural spine continuous with the body of the vertebræ. They are, however, at once distinguished by their flat, smooth, articular surfaces, and the absence of the elongated tubercle in the centre. Eleven posterior cervical vertebræ (4 *a*) have a length *in sitû* of 2 feet. They were found on the exposed surface of a slab, and are therefore water-worn, so that their transverse dimensions obtained are not trustworthy, but they appear to have been about 3 inches in diameter. In the same slab is a fragment of a shaft of a humerus, and the margin of a coracoid (4 *b*, *c*), with a scapulo-humeral articulation, which seems to have resembled closely that of *Mauisaurus*. The proximal end of a humerus (4 *d*), found by Mr. McKay at the Amuri Bluff, has been referred to this species on account of associated vertebral fragments. The articular head of the bone is peculiar, being divided into two portions by a bicipital notch, not a groove, as in *Mauisaurus*. The external part of the facet is a square, flat-topped, trochanter-like process, but continuous with the curve of the inner portion, which is nearly circular, convex, and deeply pitted, in the manner of *Plesiosaurus*. It is not improbable that both this and the last-mentioned species should be referred to Professor Owen's genus of *Pleiosaurus*.

5. Plesiosaurus traversii, n. sp.

This is a very marked species, easily distinguished by the large quadrate centra of the vertebræ, that always show a tendency to split into four parts in the line of the venous foramina, and a constriction of the lateral border.

No. 5 *a*.—Nine cervical vertebræ, much water-worn, but showing the



A. PLESIOSAURUS CRASSICOSTATUS.
B. B′. B″. " HOODII.

J. B del. et lith.

peculiar character of the species. Transverse diameter of the centra 4 inches, vertical diameter 3·5 inches, antero-posterior length 2 inches. The neural spines are 1·7 inches in antero-posterior width, 4·5 inches long, leaving only a very narrow space between, and this is deeply notched by a bold zygapophysial articulation 1·3 inches in depth.

No. 5 *b.*—Is a slab with several vertebræ, and also obscure fragments of the lower jaw, among which is a single tooth *in sitû* (Pl. XXIV., fig. H). This tooth is 2·2 inches long, and ·3 inch in greatest diameter, which is at the base of the crown, at 1 inch from the tip. It is a curved, flattened, produced cone, without any sign of a sharp ridge like that seen in the supposed tooth of *Mauisaurus*, to which, however, the species has some affinity, but is easily distinguished by the shorter vertebræ and the quadrate, not circular, form of the articular facets.

6. PLESIOSAURUS MACKAYII, n. sp.

This species is not unlike the last described in the form of the tranverse section of the centra of the vertebræ, but their length is very different, being almost equal to the vertical diameter, as in *Mauisaurus.* But it is distinguished readily from that genus by the form of the humerus (6 *a*), which is dilated at the distal end with a rounded articular extremity, and at the proximal end is feeble. The shape is somewhat prismatic, but the bone has been a good deal water-worn before being imbedded in the matrix. The clavicular bone is slender, with a well-marked oblong articular surface. A fragment of the coracoid bone shows this apparatus to have been very powerful, the width being about 7 inches, with a very strong symphysial surface. The articular surface at the angle of the bone for receiving the humerus is elongate and narrow, being 1·7 inches wide at the middle, and tapering both ways, to a length of 4 inches. The vertebral centra preserved, which belong to the dorsal region, have the following dimensions:—Antero-posterior diameter 3 inches, transverse 4 inches, vertical 3·2 inches. The humerus measures 13·5 inches in length, and is 8 inches wide at the dilated extremity.

7. POLYCOTYLUS TENUIS, n. sp.

This genus, according to Professor Cope, has close affinities to *Plesiosaurus*, but is distinguished by short deeply-concave vertebral centra, the concavity not, however, being of an open conic form, as in *Ichthyosaurus*, but distinctly flattened at the fundus. The limb bones are remarkable for their size compared with the vertebral column, indicating powerful natatory capacity. To this genus, under the above specific name, I provisionally refer the specimens marked 7 *a*, *b*, *c*, and *d*, all of which were obtained at the Amuri Bluff. The first consists of two slender paddle bones and one centrum, probably cervical. The length of each paddle bone (humerus?) is 9 inches,

the proximal end is slightly expanded, 2·5 inches in diameter, and presents two distinct regularly convex articular surfaces. The distal extremity is compressed, but, unlike *Plesiosaurus*, the compression is at right angles to the greatest diameter of the other end of the bone, and is 4·5 inches in diameter, by 1 inch in width. The vertebral centrum is circular, with two very distinct inferior foramina. There are four articular facets, two on the upper and two on the lower quadrants, for the neural arch and the costal processes respectively. The articular surfaces of the centrum are deeply excavated and concentrically striated, but with a well-marked central elevation and pit. The diameter of the centrum is 1·9 inches, its length 1·2 inches, and the thickness between the conical excavations of the articular facets is ·7 inch.

No. 7 *b*.—This specimen is associated with the above on account of the double facet on the proximal end of the humerus, which is 10 inches long. The vertebræ included in this slab are proportionately larger but not so concave as in the type. They are from the posterior dorsal region, and measure 2·5 inches in length by 3 inches in diameter.

No. 7 *c*.—The occurrence of a vertebral centrum, having the character of this species, connects with it provisionally a fragment of a pelvic arch contained in another slab. It consists of a hatchet-shaped pubic bone of the right side, articulated to a portion of the corresponding bone of the left side by a symphysis 4 inches long. Where these bones unite they are thickened so as to form a wide triangular surface of attachment.

8. Mauisaurus haastii, n. sp.

The Sauropterygians referred to this genus are easily distinguished from *Plesiosaurus* by the character of the coracoid and the elongated vertebræ. In the latter respect it approaches the genus *Elasmosaurus* of Cope, but differs from it in the scapular arch, and particularly in the powerful muscular attachments evidenced by the humerus.

The huge reptilian distinguished by the above name is only represented in the collection by vertebræ, paddle bones, and coracoids, and a few rib fragments, of at least three individuals, obtained from the Cheviot Hills and the Amuri Bluff. No skull fragments or teeth have been found which can be referred to this animal, unless it be three teeth and a matrix cast of a portion of the jaw of a specimen (8 *h*) obtained at Boby's Creek, Waipara, by Mr W. T. L. Travers, and which is reported to be a fragment of the same block that was lost in the Matoaka, that contained the fine jaws and teeth described by Dr Haast.*

One of these teeth has been figured (Pl. XXIV., G *a*, *b*, *c*). It has a compressed, conical, slightly curved form; the crown is of dense black enamel, with a slightly swollen ferruginous base that is obliquely truncate and

* Haast, Trans. N.Z. Inst., II., 186.

excavated by a shallow pit. The enamel layer is seen, in the section (*a*), to thin out on the cement, and is not reflected to line a pulp-cavity, as in *Leiodon.* The external surface is very slightly rugose, and has a single ridge on the convex, or anterior, surface. The length is 1·5, and diameter ·5, inch.

No. 8 *a.*—The total stretch of the scapular arch and anterior limbs could not have been much less than 9 feet from tip to tip of the paddles. The coracoid bones resemble *Ichthyosaurus* in form, being each 12 inches wide by 15 inches long. They are attached by a strong articular surface for 14 inches in the middle line, the thickened margin of the bone having been supported by strong ridges.

In this fine specimen, which was obtained by Dr. Haast in a soft matrix of blue clay shale in the bed of the Jed River, in the Cheviot Hills, twenty miles south of the Amuri Bluff, the coracoids were found attached along the mesial line by a thick massive suture, but thinning posteriorly, the middle portion of each bone being very thin, so that it could not be preserved. There are, however, at least two stout transverse ridges. The external anterior angle presents two articular facets, the anterior being one-third less than the posterior, and apparently articulating with the scapula, while the posterior formed two-thirds at least of the glenoid cavity.

The general form given to the coracoids is from the sketch taken before the bones were removed from the soft matrix in which they were found to be imbedded, but the attempt to restore it from the fragments has not been successful.

DIMENSIONS OF THE CORACOID.

	Inches.
Anterior margin	8
Anterior articular facet	3·5
Posterior articular facet	4·5
Posterior margin	14
Mesial articulation	15
Greatest thickness	3
Thickness of articulation of glenoid	3

Scapula.—Of this bone only a proximal fragment, 6 inches long, has been preserved. It presents a quadrate articular surface, 4 inches along the diameter for attachment to coracoid, and a rough deeply-grooved articular surface forming part of the glenoid cavity, the groove corresponding in position with the bicipital groove on the humerus. The bone appears to taper rapidly, the diameter where broken across being only 2 inches, while that of the articular end is 4 inches.

Humerus.—This is well preserved in 8 *a*, *b*, and *d*, in every case presenting nearly the same dimensions and character. It is greatly thickened at the proximal end to form a hemispherical articular surface and an expanded trochanter-like process, which are separated by a deep bicipital groove,

giving it more the look of a cetacean than a reptilian limb-bone. The distal extremity is flattened at right angles to the greatest expansion of the proximal, and has two distinct, slightly concave, articular surfaces to receive the ulna and radius. The plantar surface is smooth and slightly concave. The palmar surface slightly convex, and has a bold, rugose tuberosity in the middle to receive the attachment of the bicipital tendon, indicating powerful rotatory movements of the limb.

DIMENSIONS.

	Inches.
Length	11·5
Diameter—articular surface	5
Diameter—neck	4
Length—trochanteroid surface	4·5
Width	2·5
Width—middle of bone	4·5
Thickness	2·5
Width—distal extremity	9
Thickness	2·5

Radius.—A pentagonal bone, with thin external margin and convex articular surfaces, and with a notch on the surface in contact with the ulna. It has two carpal articulations.

	Inches.
Length	3
Width	2·8

Ulna.—A hexagonal bone, with convex articulation.

	Inches.
Length	3·5
Width	4

Carpals.—The radial is cuneiform, with three articular surfaces and a bevelled external.

	Inches.
Length	2
Width	3

The *intermedium* is pentagonal.

	Inches.
Length	2·5
Width	2·5

Ulnare is hexagonal, with five articular surfaces.

Distal Carpals.—1st has four articular surfaces, is rounded, and channelled externally.

	Inches.
Length	1·5
Width	2·5

It articulates with two phalanges.

2nd also articulates with two phalanges, having, in all, five articular surfaces.

3rd is also pentagonal; articulates with only one phalange and the *ulnare;* the other surfaces not having perfect articulations.

J.B del et lith.

MAUISAURUS HAASTII, *n. sp.*

The quadrate character of the radius and carpal bones, and the grouping of the digits into three radial and two ulnar, indicates a difference from the ordinary Plesiosauroid.

The digits, however, are distinct, the phalanges being subcylindrical, compressed in the middle, and with distinct terminal articular surfaces. The proximal phalanges are 2·7 inches in length, and the 5th row are 2 inches.

As the smallest phalanges which have been obtained—1 inch in length by ·25 inch in diameter—still have articular surfaces and a constricted form, the digits must have been enormously prolonged to produce such attenuation. The total length of the paddle was probably not less than 5 feet.

No. 8 *b* is a slab got by Mr. H. H. Travers from the Amuri Bluff, in which were obtained, in addition to paddle bones and two cervical vertebræ, several rib fragments, which show that the rib had a wide, expanded, articular capitulum, which was apparently convex. The rib is rather sharply bent, with a thin inner edge, and a flattened, channelled surface, the cross section being a constricted oval.

No. 8 *c*.—Anterior dorsal vertebra, also collected at the Amuri Bluff by Mr. H. H. Travers, is a very finely-preserved specimen that has been worked out successfully from a hard matrix.

Centrum nearly circular, each vertebral diameter nearly equal to height, constricted one-fifth of the full transverse diameter at the middle part of the bone, where it is also compressed inferiorly. Articular facets very slightly concave, with central pit, on a raised tumid tubercle. Neural canal small, one-fifth the diameter of articular facets. No neural suture, the neural arch being simply a reflection of the lateral surface of the centrum, rising in the middle and supporting a large diapophysis, then springing from two ridges that bound a wide, shallow, smooth depression. The base of the diapophysis is trihedral. The upper surface is horizontal, and the lower, which is vertical to the centrum, is oblique, and excavated by a groove.

This process is expanded at the tip, with a slightly convex articular facet for the rib attachment. The length of the process is nearly equal to the height of the centrum.

The præzygapophyses are one-fifth the height of centrum in length, and one-eighth in width; being very feeble in proportion to the size of the bones. Their convex articular surface is deeply emarginate.

Post-zygapophyses are broken off. Neural spine equal to half vertical diameter of the centrum in length at base, and one-fifth the same in width.

The full height of the vertebral segment is 9 inches, or nearly twice the vertical diameter. Inferior surface has a bold mesial ridge separating venous foramina one inch apart.

DIMENSIONS.

	Inches.
Height of centrum	5
Transverse diameter of centrum	5·5
Length of centrum	4·2
Præzygapophysis	1·3
Diapophysis—length	4·5
,, width at base	1·6
,, articular facet	2

No. 8 *b.*—This specimen, already referred to, also has two similar vertebræ, but less perfectly preserved, the dimensions agreeing exactly, so far as can be ascertained.

A centrum of a similar vertebra was found with the paddles at the Cheviot Hills, but as its length is one-fourth less, and the other dimensions are proportionately small, the Cheviot Hills specimen, notwithstanding its vast size, must have been greatly surpassed by those from the Amuri.

No. 8 *d.*—A paddle, also from the Amuri Bluff, the only divergence from the foregoing character being in the form of the ulna, which is decidedly more Plesiosauroid.

No. 8 *e.*—Four vertebræ, having the characters of the foregoing, but of smaller diameter, and without the long lateral processes; are, probably, from the anterior dorsal or cervical region of an individual of this species.

No. 8 *f.*—This is a large slab, which measures 4 feet in length, containing vertebræ which I refer to this species, showing that the neck had enormous proportions, the transverse diameter of the centrum being 4 inches, vertical 3 inches, and the length 3·5 inches. The neural spines are immensely elongated and closely interlocked, having a height of 5 inches, and a width of 2·7 inches. Thirteen vertebræ have been preserved in a continuous series, having a length of 3 feet 6 inches. The neck has been curiously twisted, so that the anterior four vertebræ have the ventral surface reversed in relation to the others. The four posterior vertebræ have hatched-shaped transverse processes. They resemble the description of the cervical vertebræ of *Elasmosaurus*, but present a marked difference in having the width of the centrum greater than its height, while the proportional length of the centra, and the large, firmly-anchylosed neural arches separate it from *Plesiosaurus*.

No. 8 *g.*—Several dorsal vertebræ belonging to this species are in the Canterbury Museum.

9. MAUISAURUS LATIBRACHIALIS, n. sp.

No. 9 *a.*—This specimen, obtained at the Amuri Bluff by Dr. Haast, is the proximal portion of a humerus of much larger size, and differs in its proportions from any of the foregoing, the width through the tuberosity being as 7 to 4, and also, at the same time, being so much compressed as to indicate a decided specific difference.

9 *b*.—A humerus corresponding with the characters of this species, but having also the ulna or radius, and some of the smaller paddle bones, is in the Canterbury Museum, according to Mr. A. McKay, who thinks the specimen came from Heathstock, in the Waipara.

LEIODON, Owen.

This genus was distinguished from *Mosasaurus* by Owen, by the form of the teeth, which are smooth, curved, and slightly compressed, so that in section they show an ellipse sharply pointed at both ends, and also by the mode of attachment of the teeth to the jaw bone. According to Professor Cope, it is abundant in America, being a characteristic fossil of the cretaceous formation, four species having been obtained from the western, four from the eastern, and two from the southern, cretaceous rocks of the United States; while the only other known species is represented by the jaw fragments found in Europe, and described by Professor Owen. The characters of the vertebræ show it to have been an exceedingly elongated reptile, one of the American species, the individual bones of which are not larger than those now to be described from the Amuri, having belonged to an animal which was not much short of 100 feet in length.

10. LEIODON HAUMURIENSIS, n. sp.

No. 10 *a*.—This is a portion of a skull of a gigantic species, which I refer to this genus on account of the character of the teeth. It consists of the whole tooth series of the upper jaw and the corresponding portion of the lower jaw of the right side, and the anterior half of the lower jaw of the left side, which was worked out from the lower part of the slab. There are 15 teeth, averaging two inches apart, above and below; the mature teeth rising from a distinct elevated crown of cement—characteristic of this genus—while the immature teeth push their way through the cement, generally alongside or slightly internal to the base of the old teeth. The largest mature teeth have a black enamelled crown 1·5 inches in length, slightly curved outwards and backwards, compressed laterally with an obtuse anterior ridge, and more rounded but still slightly angulate behind, the surface being irregularly striate but not channelled. The long diameter of the base is about ·9, and the short diameter about ·6, inches. Pulp cavity is filled with rock matrix, and the section shows it constricted where implanted in the dental cement. The internal cavity of the tooth shows more lateral compression than the external surface. It is lined with a black layer, between which and the enamel the dental substance is yellowish white. The total length of the tooth series is 26 inches; the jaws are quite straight and not curved towards the symphyses, and appear to have been set at a moderate horizontal angle, so that the muzzle must have been long and narrow.

Both jaws are prolonged as blunt processes for 2 inches beyond the tooth series, and show no sign of terminal teeth. The height of the lower jaw at first tooth is 2·5 inches, and at the tenth tooth 3·5; and the upper jaw appeared to maintain its width in the same remarkable way.

No. 10 *d.*—A string of 10 lumbar vertebræ, from the Waipara, appear also to belong to this genus. They are procœlian and subprismatic in section. The neural spines are not well preserved, but were attached along the whole length of the vertebræ. The lateral processes (*pleurapophyses*) are short stout cylindrical tubercles, 1·5 inches long by 1·3 inches in diameter, with rounded extremities, received into distinct articular surfaces on the heads of the ribs. The surface of the bodies of the vertebræ is roughened and striated. They slightly expand towards both articular extremities, therein differing from another genus to be described. The articular surfaces are smooth, and the posterior extremity is marked by the peculiar epiphysial ridge shown in the drawing of *Mosasaurus* vertebræ in Mantell's "Fossils of Sussex."

The neural spines are remarkable for their great breadth, being 2·5 inches long and 3 inches high, and also for the very strongly striated surface, which character appears to be common to nearly all the flat bones of this reptile.

The dimensions of the vertebræ are :—

	Inches.
Transverse	3·5
Height	3
Length	3·5

No. 10 *e.*—I refer to this species 7 ribs, which are flattened and channelled deeply on the internal surface, and very much expanded towards the head, where they have well-developed articular processes, which are irregularly cup-shaped, with thin margins. They taper very much in the other direction.

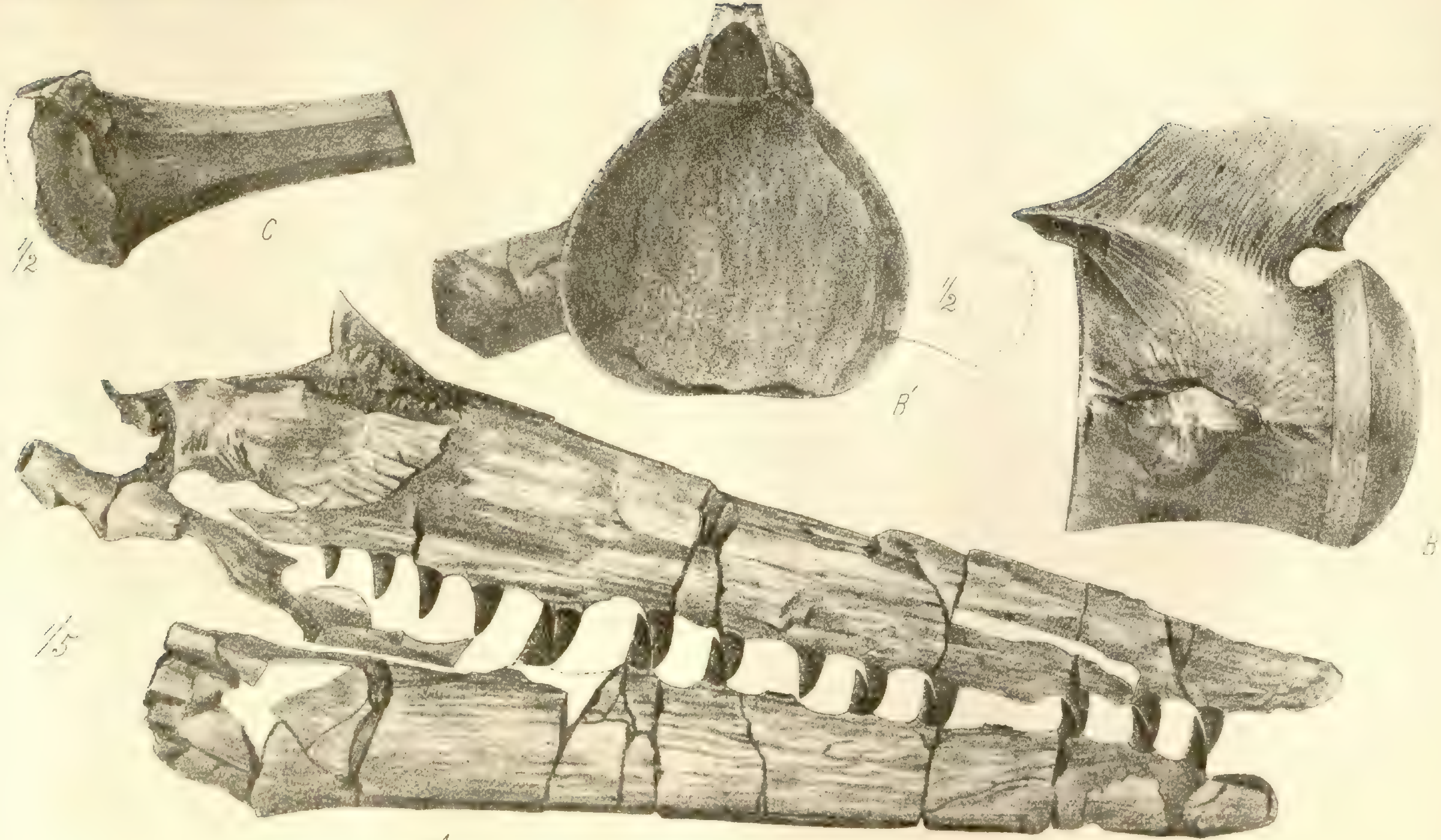
Longest rib, of which there are 8, is 18 inches; also two abdominal ribs and three phalanges.

These were found in a slab at the Waipara, close to the vertebræ (10 *d*), and the evidence for connecting them with this genus is afforded by the peculiarly-excavated form of the head of the rib, which appears to fit the articulated surface on the tubercle, and also their striated surface; and, further, certain fragments of spinous processes intermixed with the ribs also assist in this determination.

No. 10 *f.*—Three caudal vertebræ, from the Amuri Bluff, evidently belong to the same species with the above, and form one of the most important links in connecting palæontologically these widely-separated localities.

No. 10 *b.*—A slab of 20 caudal vertebræ, chevron processes, and neural spines, which also belong to this species. Obtained from the base of the boulder bed at the Amuri.

The most anterior vertebra is 2·3 inches in diameter, whilst the last



LEIODON HAUMURIENSIS.

J. B del. et lith.

vertebra of the string has its centrum 2 inches in diameter. There is, however, one detached vertebra of minute size, the centrum being only ·75 inch, which would apparently indicate that the diameter of the caudal vertebræ either diminished suddenly, or that the number must have been very great. The length of the centrum is 1·5 to 1·2 inches, while that of the single small vertebra is only ·5 inch.

They are all procœlian, quadrilateral in section, with a small triangular neural canal, enclosed by a stout spinous process 3 inches in height by 1 in width.

The chevron bones are 5·5 inches in length, the bifurcate processes 1·5, articulating with facets on the lower aspect of the centra, and obliquely directed backwards, in the same way as the first of the series of chevron bones in the Tuatara.

No. 10 *c.*—Eight vertebræ from another slab, also from the Amuri Bluff, probably from the cervical portion of the column. They are connected with the foregoing, from the striated character of the spines and the procœlian form of the centra. The inferior surface of one is well preserved, and shows a width between the insertion of the lateral processes of 1·7 inches, or about the same as that of the anterior articulations. The excavation on the inferior surface of the centrum, beneath the lateral process, corresponds closely with that observed in 10 *d.*

No. 10 *g.*—Jaws and teeth of a fine specimen, collected by Dr. Haast at the Amuri Bluff, but still imbedded in the blocks of matrix, appear to belong to this species.

No. 10 *h.*—Lower jaws of both sides, with the tooth series exposed, but in a very broken and displaced condition. The jaws appear to be curved and set at a wide angle, resembling the figure of *Mosasaurus*; but the form of the teeth and the other characters place the specimen with the narrow-muzzled *Leiodon*, so that the apparent width of the mouth indicated in this specimen must be attributed to dislocation.

No. 10 *i.*—In the Canterbury Museum are several vertebræ from Waipara, which agree with the characters attributed above to *Leiodon*, and probably the *Teleosaurus*, mentioned by Mr Hood as having been sent home in the Matoaka, is to be referred to this genus.

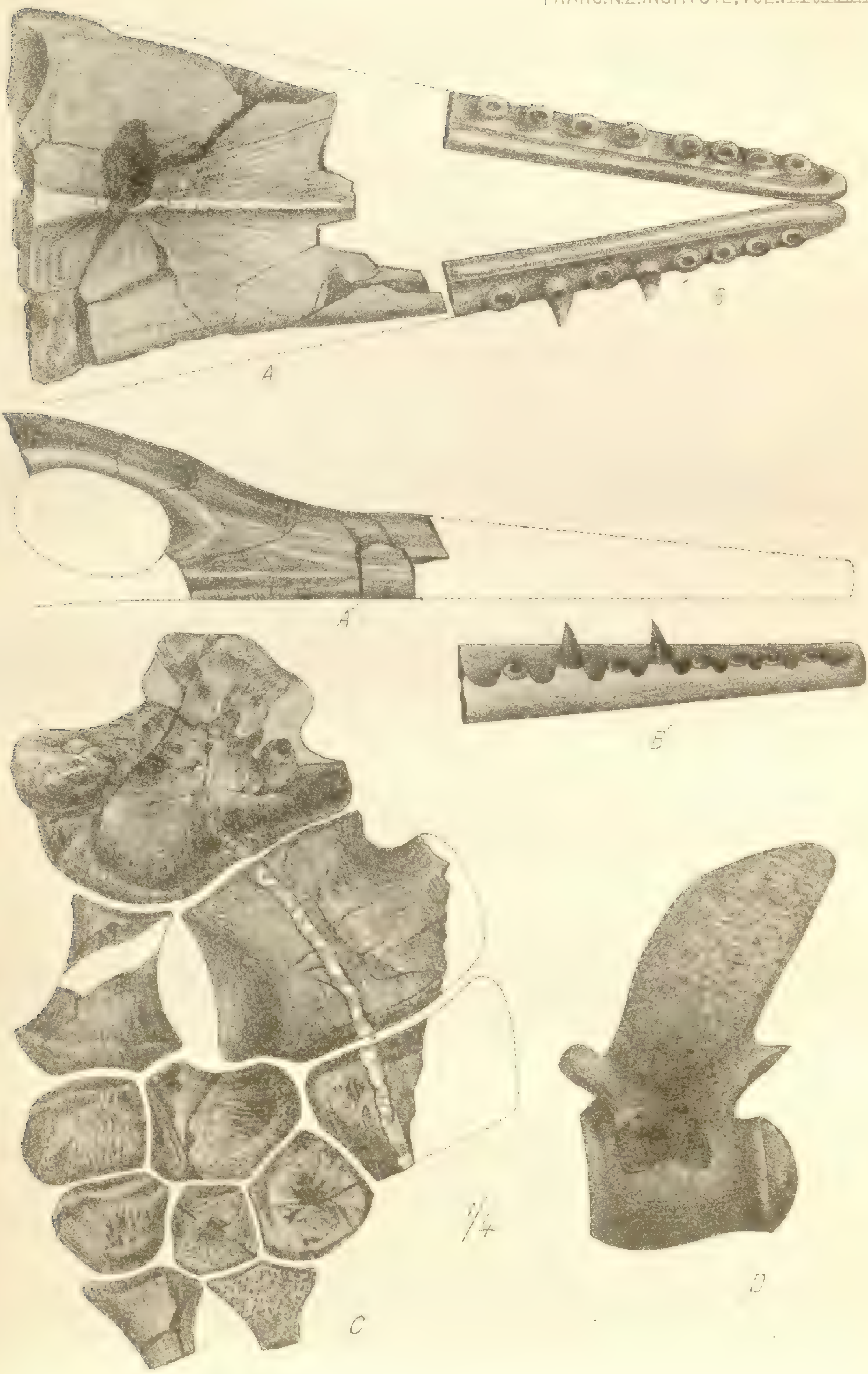
11. TANIWHASAURUS OWENI, n. sp.

I have applied this term to a mass of vertebræ, a skull, and paddle bones from the Amuri Bluff, which, though occurring in three separate portions, have been identified as belonging to the same species. The dorsal vertebræ, of which seven are preserved, are procœlian, and characterized by their bodies having a greater anterior than posterior diameter, the cup end having a much greater diameter than the ball which it receives. The plane of each

articular surface is, moreover, displaced obliquely backwards with reference to the general axis of the vertebral column. Surrounding the ball end of the vertebra is a very distinct capsular ridge and groove. The neural arches are continuous with the anterior portions of the centra, and articulate by bold transverse processes, the anterior being the longer in each case. A slight overhanging continuation of the anterior margin of the spine over the neural canal seems to indicate a rudimentary zygosphene.

The ribs appear to have articulated with a rough surface, placed on the anterior and upper part of the centra. A few fragments of ribs are preserved, and show the articular head to have had a convex surface. The inferior two-thirds of the circumference of the centra presents an even striated surface. The centra are compressed laterally, but not constricted; length 4 inches, height 3·5 inches, transverse diameter of anterior articular surface 3·5 inches, posterior about 3 inches. The ribs, which are 1·5 inches wide, are flattened, and only slightly expanded at their insertion.

The paddle bones are very remarkable, and differ altogether from anything else in the collection. The humerus is extremely short in proportion to its width, having a flattened form, and strong irregular much-recurved anconal processes. Its length is 6 inches, proximal width 3 inches, distal width 6 inches. Radius 4·5 inches in length, 3·5 at the distal extremity, and 2·5 in the middle. The carpals are remarkably thin and flattened, their borders being raised and roughened. Only a few fragments of phalanges are preserved, from which they appear to have been rather elongate cylindrical bones expanded at both ends. The head is preserved in two portions from the orbit forwards, but a part is wanting in the middle. The orbital width is 7 inches, and the total length was about 24 inches; the length of the tooth series 14 inches. The form of the symphysial surface uniting the two rami, and the angle of divergence which they show, would make the gape about 7 inches wide, or about half the length of the tooth series. The teeth are badly preserved, but consisted of a thin layer of enamel enclosing a widely conical cavity, not constricted at the base. The teeth are finely striated, only slightly compressed, and without any well-marked ridge; length, 1 inch, greatest diameter at base ·8 inch. Although firmly imbedded in cement they appear to have been attached by thin bases to the inner side of the floor of the dental groove, the exterior parapet being very low, so that the teeth must have been set in the jaw with a marked lateral divergence, and not placed vertically as in *Leiodon.* This is shown in two sections of the jaw on Plate XXVI., figs. *b* and *c*, but in which the lines XY are perpendiculars, the drawings having been wrongly placed on the stone. By working out the base of the skull, which is much fractured, a smaller and more cylindrical tooth was exposed, which was probably a pterygoid tooth, such as are found in *Mosasaurus.* The cranial



TANIWHASAURUS OWENI. *n. sp.*

J. B. del. et lith.

bones which have been exposed have a thin squamous structure, with ridges radiating from the centres of ossification, that give them the appearance of fish bones. The orbit is well defined by a distinct bony arch having a rounded margin.

13. ICHTHYOSAURUS AUSTRALIS, n. sp.

This genus is only represented in the collection by a single vertebral centrum, in a matrix of dark-coloured, fine-grained, micaceous sandstone belonging to the rocks of Mount Potts, in the Rangitata district of the Province of Canterbury. Dr. Haast thus describes the strata from which the specimen in question was obtained:—The beds are here "represented by a great thickness of dark shales, often becoming so slaty that they may be termed clay-slates, alternating with thinner layers of sandstone, sometimes with a ferruginous or calcareous matrix. Amongst these occur a few beds of conglomerate, which fairly may be termed bone beds, as they consist, besides boulders and pebbles of light-coloured slates, of great quantities of well-rounded pieces of bones and broken shells. The former often show considerable dimensions. I was thus able to measure the proximal end of, probably, a humerus, which I found to be 8 inches across, and some other bones of similar dimensions. However, the bones, as before observed, were so much rolled, and the cementing medium of such considerable hardness, that I was unable, with the tools at my command, to procure any characteristic specimens, but I have no doubt that they are of Saurian origin. No teeth were visible amongst this bone breccia."*

From the associated fossils Dr. Haast concludes that these beds are of carboniferous age, but they appear to be identical with strata that, in other parts of the colony, are considered to be triassic.

The foregoing imperfect notes have been prepared under great disadvantages from want of the necessary works of reference, and sufficient leisure from other duties for conducting so intricate an investigation ; but it is hoped that they will serve to indicate the extraordinary variety and interest of these fossil remains, which prove that the ocean during the upper mesozoic period was, in the Southern as in the Northern Hemisphere, tenanted by huge Saurians performing the functions in the animal economy that are now fulfilled by the predaceous Cetacea and marine Carnivora.

NOTE. Jan., 1874.—Having visited the Amuri district since the foregoing paper was written, I have arrived at the opinion that the section exposed at the Amuri Bluff, from which the Saurian remains were obtained, includes a lower formation than any yet found in the Waipara district, and that this lower group can be distinguished by its included fossils.

The section is much obscured by landslips at the points where the most

* Geol. Surv. Rep., 1873, p. 5.

important junctions occur, but the following is an approximation to the sequence and thickness of the strata, as seen in descending order along the north-east face of the bluff.

I.—*Chalk Group.*

a. Leda Marls (700 feet).—Greenish sandy and argillaceous marls, with hard and soft layers. *Pecten zitelli, Leda, Waldheimia, Scalaria, Cidarites*, and *bone fragments.* These marls strike N. 40° E., with an increasing dip from 15° to 40° towards the base, where they gradually pass into greensands or yellow calcareous sandstone speckled with glauconite.

b. Fucoidal Limestone (50 feet).—An indurated calcareous sandstone, generally separated from (*a*) by a thin layer of brecciated fragments of calcareous greensand, but frequently the greensand is interlaminated, and fills the fucoid casts. The character of this junction is constant over a large area—from the Weka Pass to the Kaikoura—but at the latter place a corrugated concretionary disturbance of the calcareous beds has given rise to an apparent unconformity. *Fish teeth* and *Fucoids.*

c. Flaggy Limestone (30 feet).—Yellowish-white, smooth-grained limestone, like indurated chalk, in thin layers. *Pentacrinus, Pecten* (fragments, like *P. hochstetteri*), *Inoceramus* in large fragments.

d. Cherty Limestone (300 feet).—Chalk, with flints. At Kaikoura the flints are more abundant, and are sometimes quite black.

e. Grey Limestone (100 feet).—A gritty, subcrystalline limestone, weathering white. *Worm casts* and *Pecten.*

f. Chalk Marl (300 feet).—With hard indurated bands and layers of greensand.

II.—*Greensand Group.*

The strike changes in this group to N. 20° E., the dip being 30° E.S.E.

g. Teredo Limestone (20 feet).—Dark grey, subcrystalline, ferruginous limestone, weathers red, almost entirely composed of *Teredo casts.* Contains *Trigonia alæformis* var., and *Pentacrinus.*

h. Greensand (20 feet).—Incoherent, rather coarse-grained, clear sands, of bright colours, generally green.

i. Concretionary Greensand (300 feet).—Calcareous green or grey sandstone, with large calcareous concretions irregularly dispersed. *Cucullæa* (*alta ?*), *Dentalium* (like *D. irregularis*, but with large and small ridges alternating), *Tellina* (*scitulina ?*), *Leda, Scaphites* or *Hamites, Ammonites* (like *A. daintreei*, but still more compressed), *Belemnitella lindsayi* (n. sp., also found over the brown coal at Green Island, near Dunedin), *Inoceramus* (large fragments). *Plesiosaurus australis* (No. 1 *b*) was obtained from this stratum.

k. Boulder Sands (100 feet).—Dark grey, laminated, micaceous sands, with large spheroidal calcareous concretions, containing *Mauisaurus haastii, Plesiosaurus traversii, P. hoodii, Polycotylus tenuis, Leiodon haumuriensis*, and *Taniwhasaurus oweni;* also *Aporrhais ornata* and *Ostrea.*

l. Gypseous or Sulphur Sands (400 feet).—Dark grey and brown false-bedded sands, coarse and fine in grain, the upper part being greensand. No fossils, but contains pyrites and gypsum, with coaly streaks* and silicified wood. The weathered surface often covered with a sulphur yellow efflorescence.

III.—*Amuri Group.*

Strike nearly N. and S.

m. Black Grit (20 feet).—Fine-grained grit of small, water-worn pebbles of green and white quartz, and a small quantity of titaniferous iron, in a grey calcareous matrix. Fossils abundant, but all rolled.

Belemnitella, Pecten obovatus var., *Radula, Plagiostoma, Inoceramus cuvieri, Trigonia sulcata, Mytilus.* Fragments of bone and teeth, chiefly of fishes, but also Saurians—*Polycotylus, Plesiosaurus.*

n. Grey Sandstone (130 feet).—Compact calcareous sandstone, formed in parts almost entirely of shells.

Panopæa plicata, Trigonia sulcata, Eriphylla (*Dosinia*) *haumura, Axinæa* (*Pectunculus*) *cuneiforme, A. cardioides, Inoceramus multiplicatus, I. mytiloides, I. haastii, I. simplex, Aucella plicata, Radula, Alaria, Turbo, Pleurotomaria, Neptunæa, Ostrea, Crenella, Belemnites aucklandicus, B. compressus*, n. sp. Fragments of bone, teeth, and scales of fish.

o. Calcareous Conglomerate (70 feet).—Light grey calcareous sandstone, with pebbles interspersed, chiefly of black siliceous sandstone and layers of fossils, principally *Belemnites* and fish teeth.

IV.—*Jurassic.*

Green argillaceous sandstones and shales, with spherical concretions and obscure plant remains. These resemble the plant beds, or Mataura series, of the south of Otago, and the Putataka beds, in part, of the North Island, which are characterized by *Tæniopteris, Camptopteris, Pecopteris*, and Conifers, accompanying irregular seams of coal. There is distinct unconformity between these strata and the foregoing, and on the western side of a narrow ridge of these jurassic rocks the same section is again repeated in ascending order on the eastern side of a syncline. But on following the beds to the western side of the same syncline, the lower members

* Pitch-brown coal, non-caking—water 14, carbon 54, ash 5.

of the section are wanting, and the upper, or chalk, group is found to rest against the older sandstone rocks of the district. In the estimated thickness of 2,500 feet of strata exposed at the Amuri Bluff, it is evident, from the fossils, that the sub-divisions as above may be, at least provisionally, adopted with advantage. The only fossil that appears to be common to the second and third groups is *Trigonia sulcata*,* and unless No. III. is the equivalent of the Belemnite beds at Waikato Heads and Kawhia, it has not yet been found at any other part of the colony than the Amuri Bluff. If it is the same formation the evidence obtained from the above section would seem to require the sub-division of the Putataka beds into two distinct formations.

Art. LIII.—*On the Teeth of the* Leiodon. By Charles Knight, F.R.C.S., President of the Wellington Philosophical Society.

Plates XXIV.—XXVI.

[*Read before the Wellington Philosophical Society, 16th January,* 1874.]

At the suggestion of our late President, Dr. Hector, I have examined microscopically the fossil teeth of the remains of the *Leiodon* in the Museum.

The aquatic Saurians are arranged under Sauropterygia and Pythonomorpha. The former had two pairs of limbs, the latter an anterior pair only. The *Leiodon* belongs to the Pythonomorpha, with snake-like bodies of immense length. The *L. dyspelor*, discovered in New Mexico, is estimated at not less than 100 feet in length, and would be, says Professor Cope, the longest reptile known, and may well excite our astonishment.

The *Leiodon* is closely allied to the celebrated gigantic *Mosasaurus hoffmanni*, or what was at first called the crocodile of Maestricht. Neither Mantell nor Owen were able to say, from the few and scattered remains to which they had access, whether the *Leiodon* is a species of *Mosasaur* or a distinct genus. The chief distinction is in the teeth, which, in the *Mosasaur*, have the outer side flat with two sharp edges, while the inner side is round. Where the teeth are absent the unsettled distinction between the *Mosasaur* and the *Leiodon* renders it probable that some of the former species may really be *Leiodon*, as suspected by Professor Cope in his paper on the fossil reptiles of the cretaceous

* *Trigonia sulcata*, n. sp. General form like *T. gibbosa*, but sculpturing different. Traversed radially by a wide groove; posterior area with radial striæ; anterior with divaricate ridges cut into tubercles by concentric striæ, that are continued over the whole surface. Valve rather flat; hinge-margin rounded and overhanging; hinge-plates strong. Length, 3·5 inches; width, 3 inches.

rocks of Kansas. You will not be surprised to find that the fossil remains in the Museum were first ticketed as "*Mosasaur.*"

Those who have read Mantell's "Wonders of Geology" will recall to mind that Mons. Hoffman discovered the remains of the *Mosasaur* in the quarries of St. Peter's Mount, in the suburbs of Maestricht; how he was despoiled of his specimen by the greedy canon of the cathedral; how, when the armies of the French Republic advanced to the gates of Maestricht and the town was bombarded, the troops were not allowed to play on that part of the city in which the celebrated fossil was known to be contained; and how, when the city was taken, the canon had to give up his ill-gotten prize, which was immediately transmitted to the Jardin des Plantes at Paris, "where," says Mantell, "it still forms one of the most striking objects in that magnificent collection." We may regard with pride and exultation the remains of the *Leiodon* in our Museum—a trophy of geological research, not a spoil of war!

The enormous jaw-bone of the *Mosasaurus hoffmanni* measured 4½ feet long; ours, of the *Leiodon*, would be less than that. I shall, in this brief paper, confine my remarks principally to the examination of the teeth, this being the work I have undertaken as a supplement to the paper by Dr. Hector.*

It is observed by Owen that the value of dental characters is enhanced by the facility with which they may be rendered available to the palæontologist in the determination of the nature and affinities of extinct species, of whose organization the teeth are not unfrequently the sole remains. I am not, therefore, disposed to undervalue the importance of the subsidiary work I have been engaged in. Mantell, by comparing the fossil teeth with those of recent Lacertæ, was able satisfactorily to place gigantic fossil remains of Tilgate Forest among the extinct species of the Pleurodont section of Iguanians. Again, among the Saurian reptiles, Owen remarks that hitherto in investigating the internal structure of the teeth of the crocodile, *Plesiosaur*, *Myalosaur*, *Monitor*, and more recent Lacertians, he had found the dentine body of the tooth to consist of calcygerous tubes radiating direct from the pulp cavity at right angles to the external surface of the tooth; but, in the *Labyrinthodon*, he found the most singularly complicated convolutions of the dentine. Through the kindness of the Hon. Walter Mantell, I am able this evening to offer you for microscopic inspection a valuable section of the tooth of the *Lab. jaegeri.* I could not show you a more interesting proof of the value of dental characters. I have here, also, a section of the human tooth, in which you will be able to trace the fine calcygerous tubes which form the minute structure of the teeth of all Vertebrates, and which, by their uninterrupted

* See Art. LII.

passage from the centre to the periphery of the teeth, unquestionably establish the view that the substance of the tooth is not built up by successive deposition of layer after layer of bony corpuscles, as maintained by Cuvier and the "excretion" theorists, but that the growth of the tooth is carried on by spreading tubuli, through which the nutrition is preserved and necrosis and absorption effected.

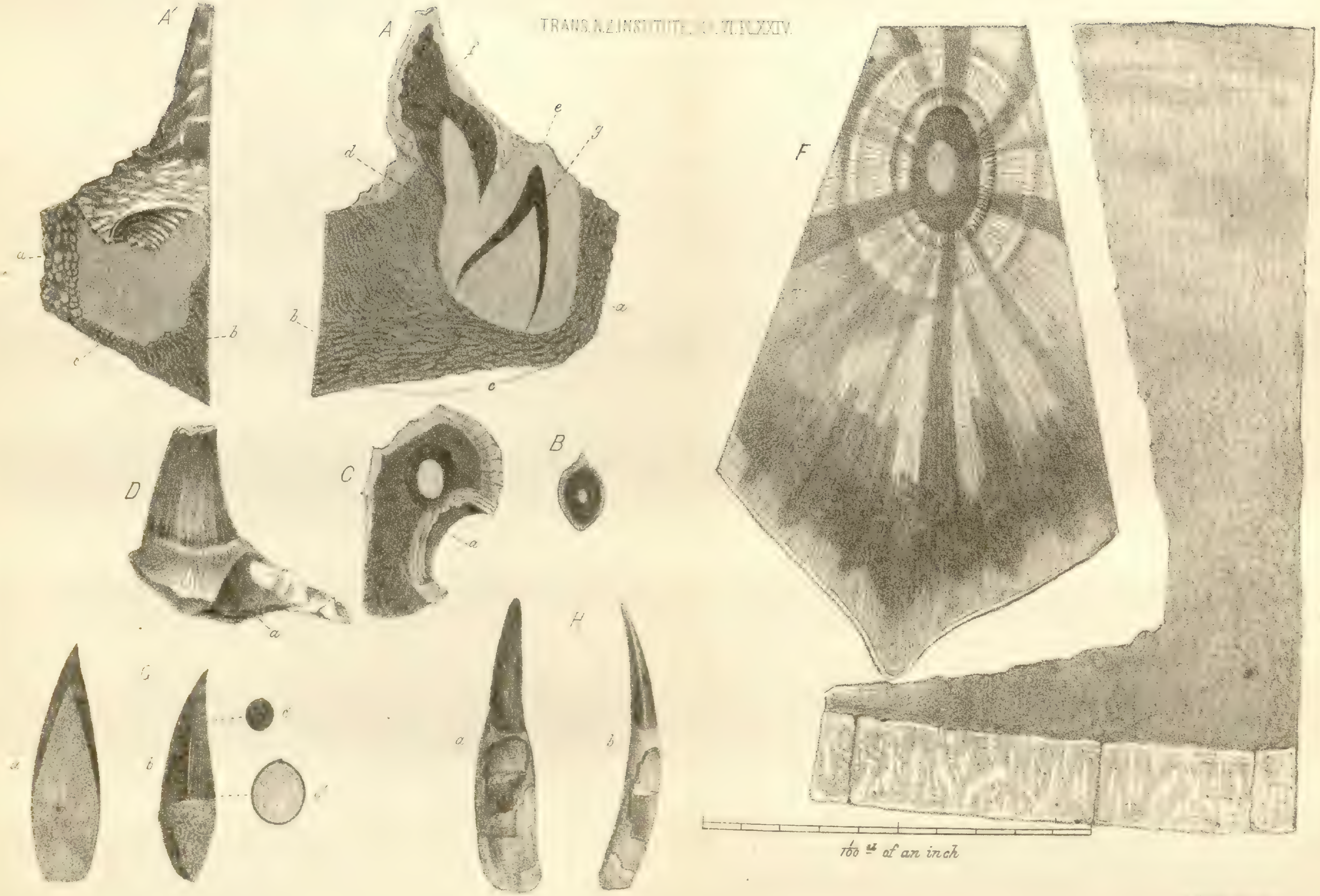
It is not the teeth only which afford interesting links in the chain of vertebrate animals. The structure of the jaw-bone is remarkable in the Lacertæ. It is built up of three or four bones, adjusted and anchylosed together; and it has been somewhat fancifully supposed by Buckland and Owen that this arrangement gives, in the case of the Crocodile and the *Ichthyosaurus*, additional strength to the jaw, and renders it better able to resist the violent concussion of their formidable mandibles when snapping at their prey.

In the mandibular bone of the *Leiodon*, it will be seen from Pl. XXV. that it is made up of four bones spliced together, viz., the dentary, the coronoid, the angular, and the splenial or opercular. The section from which the drawing is taken at once reveals to us that it formed part of the fossil remains of a Lacertian.

In the Lacertæ the jaw-bone, in most cases, presents only a sort of parapet on the outer side, and the teeth are fixed to it by a bony mass occupying the place of their root, and incorporated organically both with the tooth and the jaw-bone. In the *Mosasaurus* and the *Ichthyosauri* there is an inner parapet as well. In the *Leiodon* there is both an inner and outer parapet, with a deep fossa between, as seen in Pl. XXV.

The crown of the tooth in the *Leiodon* has a simple conical form. It is polished, striated, and of a dark colour. The numerous fine longitudinal striæ sharply marked on the polished surface of the tooth are owing to the splitting down of the *crusta petrosa.* The slits are well shown in Pl. XXIV. They do not extend to the dentine beneath. The margins, separating the outer from the inner, are well defined, and are sometimes broken by slight elevations, but this irregularity in no case gives a dentated character to the outline. Pl. XXIV. B shows the outline of a transverse section of the middle of the crown of a tooth.

The base, or fang, of the tooth presents a tapering subventricose form, and is implanted, as in the *Mosasaur*, in a cementing alveolus, raised in a rounded form from the deep longitudinal fossa formed by the ridges or parapets of the dentary bone (Pl. XXV.). The teeth, although hollow, do not, like those of the crocodile, contain in themselves the replacing teeth. Owen describes the teeth of the *Leiodon* as supported on a hillock of bone resting upon the broad alveolar surface of the jaw; but, in fact, the hillocks, or cementing



C. Knight del. et lith.

LIODON HAUMURIENSIS.

C. Knight del. et lith.

alveoli, rest on the thin floor of the dentary fossa, to whose parapets they are anchylosed, as shown in Pl. XXV.

The *Leiodon* belongs neither to the Pleurodonts, in which the teeth are attached to the inner side of the dentary bone, or, according to Owen, to an exterior alveolar plate of bone, the inner plate not being developed; nor to Pleodonts or to Cælodonts of Dumeril and Bribon, the former of which have solid teeth, attached by their bases to the groove on the inner side of the dentary bone, and the latter have hollow teeth, applied like buttresses against the outer plate of the dentary bone. The distinctive character of the teeth of the *Leiodon* is their position on elevated cementing alveoli or hillocks; hence the term Acrodonts, applied to this Lacertian and the *Mosasaurs.*

The fang of the fossil tooth is sharply defined in the vertical section of the jaw-bone (Pl. XXV.). The sides become thin and evanescent below, and the extremity, instead of being pointed, forms the wide opening of the pulp-cavity.

The expanded base of the germ of the successional tooth is developed from the inner side of the dental fossa, in the interspaces of the primitive teeth, and from within the cementing alveoli. In its growth the young tooth shoots through the alveolus, and, pressing against the alveolus adjoining the base of the primitive tooth, interferes with its contour, and at length loosens it, and causes both it and its tooth to fall. It will be seen, in Pl. XXIV. A, that the germ springs from the floor of the dental fossa, and stands with its broad base in a cavity communicating with the pulp-cavity of the primitive tooth; so that it would seem as if the young tooth was growing in a vascular, or, at any rate, not a fully ossified pulp, which, in the fossil state, has become replaced by a homogeneous deposit extending up the pulp-cavity of the adjoining primitive tooth. The germ touches the dentary bone, and must have sprung from a vascular membrane covering the floor of the dental fossa, and lining the pulp-cavity of the full-grown protruded tooth.

In order to obtain satisfactory views of the structure of the teeth, vertical and transverse sections were made. The transverse section, Pl. XXIV.F, shows, besides the dentine, an outer layer, the *crusta petrosa*, of extreme tenuity, being less than ·03 inch thick. The divisional lines, forming block-like masses, are seen on the surface of the tooth as longitudinal striæ, as mentioned above. The dentine consists of a single pulp-cavity and a system of excessively fine calcygerous tubuli at regular and minute intervals from each other, radiating from the pulp-cavity at right angles to the periphery of the tooth. The walls of the tubuli are diaphanous, and the interspaces occupied by a bony or calcified deposit, giving a somewhat cellular appearance to the dentine (E), with occasionally a pinnate arrangement of short branches shooting from the tubuli nearly across the intervening spaces. Owen notices a similar appearance in the tooth of the *Mastodon.*

The pulp-cavity is filled, in the fossil state, by a deposit of the matrix. In one of the specimens a crack passes through the tooth into the *cavitas pulpi*, and has become filled, along with the latter, with a homogeneous deposit.

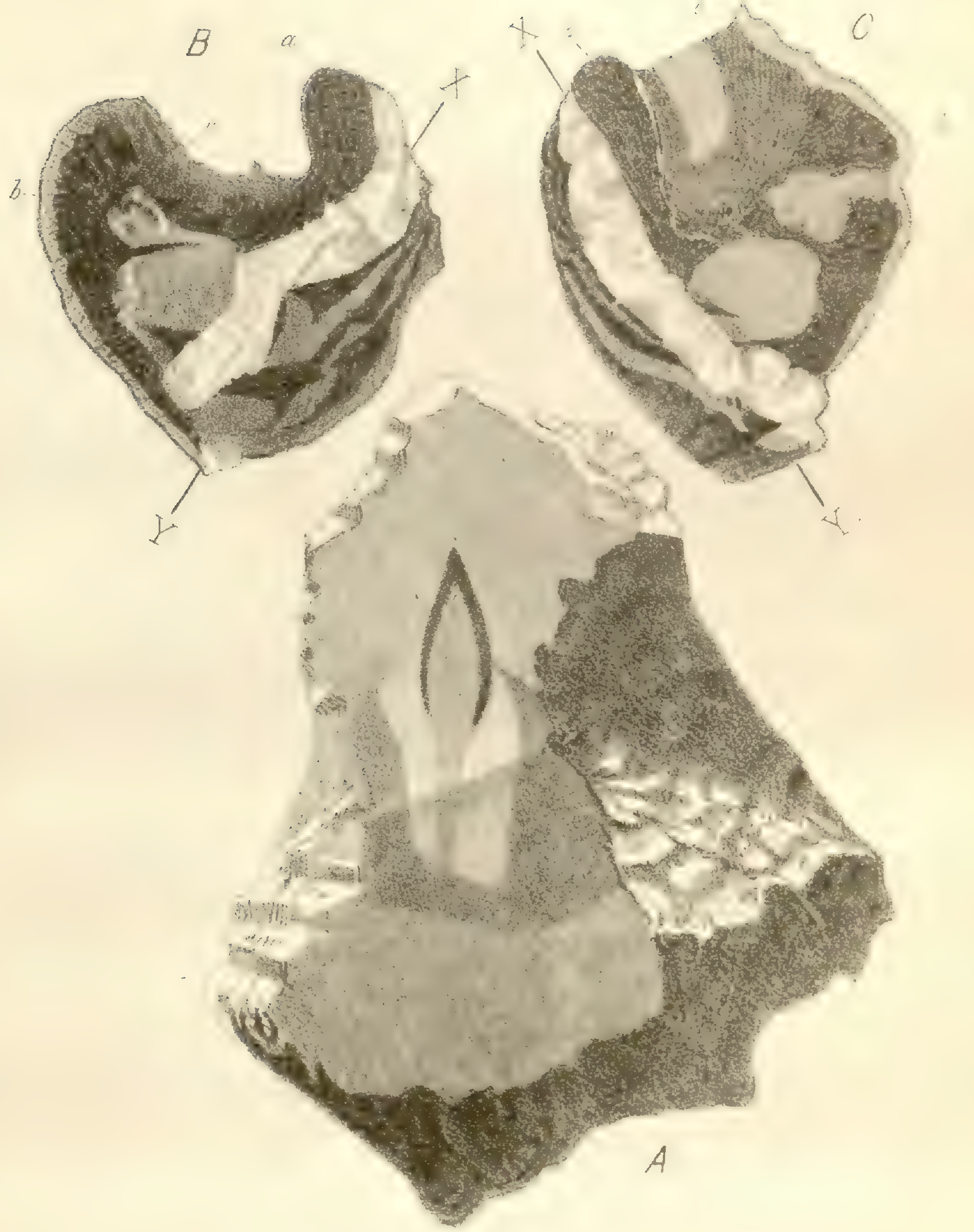
The thin *crusta petrosa* also consists of nearly diaphanous corpuscles, with numerous traces of partly effaced tubuli, so as to give ample assurance that this investing coat, like the rest of the tooth, is built up of calcygerous tubuli and calcified deposits; but, that the tubuli are no longer continuous with those of the dentine, or have any relation to the nutrition of the tooth—merely, in fact, serving as an inert, hardened crust, to protect the living dentine beneath.

There is no clear line of demarcation between what has been called the enamel and the dentine. It cannot be seen where the one begins and the other terminates. A microscopic examination shows that the tubuli (which do not exceed in diameter ·0002 inch), together with the calcareous deposit in the intertubular spaces (averaging ·0012 inch), form the substance of every part of the tooth—*crusta petrosa*, enamel, and dentine—each of these being merely modifications of continuous calcygerous tubes and bony corpuscles, of which only the crust has lost the properties of living matter. Owen must entertain the same view, although he is evidently guarded in his expressions. In his remarks on the microscopic examination of the teeth of the elephant, he notices that the tubuli of the *crusta petrosa* (or cement) appear to be directly continued from the tubuli of the ivory, although Retzius had expressly denied the continuation; and again, in his remarks on the fossil teeth of the *Mastodon*, he states that the minute terminations of the calcygerous tubes of the ivory are directly continued into the system of fine parallel tubes of the cement (*crusta petrosa*).

Towards the centre of the teeth, in a transverse section, concentric contour lines are seen, caused by an opaqueness of the intertubular deposit (F). Separation of the fossil tooth into superimposed layers takes place along these more opaque portions of the dentine, directly across the course of the calcygerous tubes, as in the fossil teeth of the elephant. Owen alludes to this in his description of the tooth of the *Leiodon*, and states that the concentric arrangement of the lamellæ, arising from the decomposition of the tooth, has been used as an argument in support of the untenable "excretion" theory.

The iridescent lustre of the polished surface of the transverse section is owing to the play of light on the reflecting walls of the radiating tubuli.

A vertical section exhibits a pseudo-cellular arrangement. The edges of the calcygerous tubes refract the light in short, brilliant lines, or appear as dark bars, about ·001 inch in length. Where the section passes through the tubuli in a more or less oblique direction, a singular appearance, which I have attempted to represent in Pl. XXIV. F, shows itself.


B
a
b
X
Y
C
X
Y
A

Description of Plates XXVII.—XXXI.

Plate XXVII.

A. *Plesiosaurus australis,* Owen. (No. 1*b*, one-fifth of natural size). *Locality*—Amuri Bluff.

General view of thorax, seen from above, as exposed in the slab, showing the neural spines traversed by a vein of calcspar, which continues through one of the iliac bones and both femora. The large quadrate pubic bones lie on either side. The ribs are recurved and continuous with the transverse processes. A few only of the dorsal and caudal vertebral centra preserved in the slab have been figured, and one group of the abdominal ribs in the upper right-hand corner.

B, C. *Polycotylus tenuis*, Hector. (No. 7*a*, one-fourth natural size.)

B, B′, humerus ; C, C′, anterior dorsal vertebral centrum.

Plate XXVIII.

A. *Plesiosaurus crassicostatus*, Owen. (No. 2*a*, one-third natural size.)

Ribs of the right side and ventral aspect of the cervical vertebræ, one of which is displaced so as to exhibit the articular facet. Three centra of dorsal vetebræ, figured in the upper part of the plate, were extracted from beneath the ribs.

B. *Plesiosaurus hoodii*, Owen. (No. 3*a*, one-half natural size.)

B, left side ; B′, ventral view ; B″, anterior view.

Plate XXIX.

Mauisaurus haastii, Hector. A. (No. 8*a*, one-sixth natural size).

General view of the coracoids and paddle of the left side, restored from the portions collected by Dr. Haast at the Cheviot Hills. The paddle has nearly one-third greater breadth than is shown, being seen obliquely in the drawing.

a, superior aspect of the humerus ; *a*′, inferior aspect of the same bone, from a cast, placed in the position of the humerus of the right side ; *a*″, side view of the humerus ; *b*, fragment of the scapula.

B. (No. 8*c*, one-third natural size.) B, posterior ; B′, anterior, and B″, superior view of an anterior dorsal vertebra. *Locality*—Amuri Bluff.

Plate XXX.

Leiodon haumuriensis, Hector.

A. Jaws, with teeth of right side. (No. 10*a*, one-fifth of natural size.)

The teeth have been made more distinct than in the original, but are copied from the jaw of the other side, in which they are well preserved. The fourth and tenth pairs are broken off and not represented, but the bases are quite distinct in the specimen. In many of the others the enamel has flaked off in working out the bones from the matrix. The specific name is from *Haumuri*, the correct Maori spelling of the name of the locality whence this fine specimen was obtained.

B. Posterior dorsal or lumbar vertebra. (From No. 10*d*, one-half natural size.)

B, view of right side ; *B*′, anterior articular surface, showing the form of the cup ; *C*, portion of rib from same slab, showing the excavated form of the articular surface.

Plate XXXI.

Taniwhasaurus oweni, Hector.

A, B. Portion of head and lower jaw. (No. 11*c*, one-fourth natural size.)

A, upper surface of cranium ; *A′*, side view of the same ; *B*, fragment of the lower jaw, seen from above, and restored to its proper position relative to the cranial fragment ; *B′*, lower jaw seen from the right side. These bones are much broken, and the drawing of the lower jaw is to some extent a restoration.

C. Paddle bones. (No. 11*b*, one-fourth natural size.)

A vein of calcspar, which is shown in the drawing, passes through the ulna and across the articulations with the humerus above and the carpal below. In the slab the radius has been displaced from its proper position, but has been restored in the drawing, and fits exactly with the other bones into its position. On the same slab, but not connected with paddle bones, are fragments of ribs and of a smooth, radially-striated pelvic (?) bone, not represented on the plate.

Description of Plates XXIV.—XXVI.

Plate XXIV.—A (*a*). Inner parapet of dentary bone of *Leiodon*. (*b*). Outer parapet of dentary bone. (*c*). Floor of dentary bone. (*d*). Cementing alveolus. (*e*). Dental fossa. (*f*). Primitive tooth. (*g*). Successional tooth.

A′ Side view of the same specimen.

B Transverse section of middle of crown of tooth.

C Base of tooth with surrounding alveolus, showing at (*a*) the encroachment of the successional tooth.

D Tooth from which the microscopic preparations were taken, showing the absorption of the alveolus at (*a*), where the successional tooth has forced its way out.

E Section of tooth showing the radiating calcygerous tubuli and the concentric contour lines.

F Section of tooth showing the calcygerous tubuli ; the portion from (*a*) to (*b*) might be considered the enamel, if really any such distinct layer exists in the teeth of the *Leiodon*.

G (*a, b, c*). Tooth of *Mauisaurus?*

H (*a, b*). Tooth of *Plesiosaurus traversii*.

Plate XXV.—Section showing tooth, alveolus, and jaw-bone of *Leiodon ;* the outline of the latter not very distinctly seen in the fossil. (*a*). Cementing alveolus. (*b*). Outer parapet of dentary bone. (*c*). Coronoid bone. (*d*). Descending process of dental. (*d′*). Angular bone. (*e*). Opercular bone. (*f*). Inner parapet of dentary bone. (*g*). Floor of dentary bone. (*h*). Pulp-cavity.

Plate XXVI.—A Section showing tooth of *Leiodon*, with channel communicating through the cement to the surface of the dentary bone.

B and C Sections of the jaw of an allied form to *Leiodon* (*Taniwhasaurus*). The lines XY should be vertical.

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

First Meeting. *6th August*, 1873.

James Hector, M.D., F.R.S., President, in the chair.

New members.—Charles W. Purnell, Thomas Lewis, Charles Rous Marten, F.R.G.S., F.M.S., W. S. Moorhouse, Hugh Calders, Wilson Heaps, George Michell Nation, G. H. Wilson.

Various publications received since last meeting were laid on the table, and a list of the principal donations lately added to the Colonial Museum was read.

The retiring President delivered the following anniversary

ADDRESS.

Before proceeding to the business of the evening I have to announce to the Society the loss of one of its most active and zealous members, through the recent death of Dr. Frederick Knox, at the ripe age of 82. More than half a century ago Dr. Knox was the assistant and friend of some of the leading anatomists of that day. As curator of the Museum of the College of Surgeons in Edinburgh, and as assistant to Dr. Barclay, he was chiefly instrumental in producing that magnificent collection of anatomical preparations, illustrative of the various forms of animal life, which is known as the Barcleian Museum. Upon the retirement of Dr. Barclay from the Chair of Anatomy, in 1824, he became assistant to his brother, the eminent and brilliant lecturer on comparative anatomy, and continued to be curator of the Museum until he emigrated to this colony in 1840. During his career in the old country he effected many discoveries in anatomy, and especially in connection with his favourite branch of study—the Cetacea; and, in his later days, he frequently had just cause to complain that many of his early discoveries, disputed or neglected at the time they were made, had been since appropriated by subsequent writers. Since the foundation of the New Zealand Society, of which he was one of the original members, he has taken a lively interest in its proceedings, and there have been but few meetings at which some anatomical preparation, evincing his characteristic skill and industry, has not been exhibited as a new addition to the Museum. His last contributions were the skeletons of the male and female elephant fish, which

have never been hitherto obtained, and he had given notice of the title of a paper describing them, which he intended to have laid before the Society this evening. I am sure that you will all agree with me that his loss will be felt at our meetings, and we shall miss the good example which he set us, of the strong and earnest love of science for its own sake.

Our Society has now been re-constituted for six years, and I think there is every reason for congratulation in the progress which has been made during that period, not only in the increased value and interest of the communications which are read to the Society, but also in the gradual increase in the number of members, and, what is still even more important, in the number of members who take an active part in our meetings.

The annual report of the affairs of the Society has been, for the first time, printed in the current volume for the year. Hitherto it has been included in the proceedings for the subsequent year. From this report it appears that, with those we have just elected, the Society includes 142 members.

The fifth volume of Transactions of the New Zealand Institute has been distributed to our members for some months, so that I may assume all who are present this evening have, at least to some slight extent, made themselves acquainted with its contents, and with the share which is occupied in it by the contributions of this Society. At our meetings last year forty-eight original papers were presented to the Society, some of which possess a value from the originality of research which they show, which will make our Transactions in future times important for reference.

In reviewing these communications, the first in order, and also in importance from the general interest which it cannot fail to excite, is Mr. Travers' history of "The Life and Times of Te Rauparaha." The career of this remarkable man is not merely of interest from its association with the early history of the colonization of these islands, but it affords a useful subject for study in connection with the more general historical question of the rapidity with which changes have been effected in uncivilized races, and the aptitude which they show in acquiring the arts, both peaceable and warlike, from conquerors or colonists, as the case may be. At the same time, this is only a small portion of the valuable material relating to the Maori race which would find a fitting place in the publication of this and the other affiliated Societies of the Institute. The Maori present a peculiarity of mental type, the reason for which is not yet fully explained. As a race they show evidence of greater mental vigour than might have been expected in a people possessing no written language. The facility with which they acquire our written language, and the delight which they take in exercising it—in reducing to writing their ancient *waiatas* (songs) and traditions—is of itself a remarkable evidence of this vigour of mind. In passing, I should, however, say that the

employment of the Maori narrators in reducing these war songs to writing does not appear to be a reliable course to adopt in their collection, as it must be a process of translation of a most complex kind, and must lead to the loss of accuracy, both in matters of fact and in form of expression.

A most interesting feature of the Maori language is the minute detail with which natural objects have been discriminated and named. In other savage races, such as the North American Indians, even those tribes which inhabited the thick forest country and had to obtain a livelihood by the exercise of the most perfect foresight and accurate knowledge of the natural phenomena by which they were surrounded, had only a few general names for objects which were not of immediate and practical utility in their affairs of every-day life. But the Maoris appear to have possessed a pure love of exercising their discriminating faculty. Every tree or shrub, useful or useless; nearly every fish, of large size or insignificant; and even many insects and lower forms of life, that would remain unnoticed by most Europeans unless specially trained to the observation of such objects, have all distinctive Maori names. The frequent reference made to natural objects in their songs and traditions invests them with a richness of imagery adapted for the poetical expression of sentiments and emotions that could only have been feebly, if they were at all, developed in the minds of the original actors and narrators. One of the most important events, therefore, which has to be chronicled for the past year, in connection with literature and science in New Zealand, is the classical embodiment of these ancient Maori traditions and songs in the poem of "Ranolf and Amohia."

All who love natural history have reason to feel grateful to the gifted author of this work for the abundant allusions which he has made to the characteristic features of the fauna and flora of the country, and the care which he has exercised in making his descriptions accurate. When a poet qualifies himself to appreciate the precise relations of the objects that enter into the scenes he depicts, he will find that it is not necessary to sacrifice either facility or grace of expression in order to obtain the impressiveness which arises from strict accuracy.

From this point of view Mr. Domett's poetical descriptions of the natural history of this new country cannot fail to aid in linking the sympathy of literature and fancy with the study of science, and so do good service to those objects which our Society has most in view.

While referring to the poetical rendering of Maori legends, I must not omit to mention the briefer, but commendable, poetical effort in the same direction by our fellow-member Mr. G. H. Wilson, whose graceful and vigorous pen has been devoted to the rendering of those legends which relate to events that occurred in past time in our immediate neighbourhood.

The papers relative to the first discovery of Moa remains, by the Hon. Mr. Mantell and the Rev. Mr. Taylor, support the view of the recent extinction of these giant birds which I expressed in my former address; and the researches in the Moa cave, at Earnscleugh, by the Hon. Captain Fraser, have resulted in the discovery of a sufficient number of bones of that curious genus *Cnemiornis* to enable me to determine its affinity to the Natatores, or duck kind, and to restore a skeleton which is now before you.* This discovery adds another instance in New Zealand of a non-volant bird with a keelless sternum, belonging to an order other members of which are possessed of full power of flight. Thus, in addition to the Kiwi and the extinct Moas, which represent the Struthionidæ proper, we have, in the Kakapo (*Stringops*), a parrot with a keelless sternum; rails without power of flight, in the *Notornis* a coot, and in the Weka (*Ocydromus*), and also a curious little rail from the Chatham Islands; while, going beyond our own country, we have the *Dodo* of the Mauritius, which was a flightless pigeon; and now we have the *Cnemiornis*, which was a large goose-like bird that apparently had neither power of flight nor of swimming. The loss of the power of flight from disuse, and the corresponding change in the structure of the bird, do not therefore appear to confer a character of such high anatomical importance in systems of classification as has hitherto been conceded to it; and, indeed, the observations of Professor Cunningham show that in the case of the Steamer Duck (*Micropterus*), which inhabits the seas in the neighbourhood of Tierra del Fuego, the power of flight is lost from disuse even during the lifetime of individuals, for, in this species, while the adolescent forms have the power of flight, the mature ducks are non-volant, the use of their wings being confined solely to propelling the bird through the water.

The additions which have been made to the zoological literature of the colony during the past year, include some important works, besides the valuable papers which appear in the volume of our transactions; chief among them is Dr. Buller's great work on the Birds of New Zealand.

It is satisfactory to learn that Dr. Buller's work is to be rendered more complete by the publication of additional plates, so as to give figures of all these birds; and, as the first edition is now exhausted, we may hope that the author will receive encouragement to republish it, and have an opportunity of bringing up the information to a still later date.

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* An old native at Hikurangi lately described to me what must have been this bird, under the name of *Tarepo*. He stated that it was not a Moa, but a short bird that made a cry like a Putangitangi (*Casarca variegata*), with very thick legs, and so strong that it could "upset a man," and that, in his youth, he had seen one alive. The Moa, he said, had been longer extinct; but, in boyhood, he had seen an old man, who, in his youth, had killed one. The name Tarepo was erroneously taken for a synonym of Moa by the late Rev. R. Taylor, in 1839 (Trans. N.Z. Inst., Vol. V., p. 97).

The enumeration of our Whales and Dolphins, which I communicated to this Society, has already called forth critical remarks from the veteran zoologist in this branch, Dr. Gray, and these, with several other communications which have appeared in home publications relative to this class, and most interesting to the New Zealand reader, have been placed in the library of the Society. I would specially refer to the elaborate description, by Professor Flower, of the skeleton of the *Berardius arnouxii*, which was sent home by Dr. Haast, and is now in the Museum of the Royal College of Surgeons.

With reference to the Seals which inhabit our coast, I may state that the examination of a large number of young and old skulls, on my recent visit to the west coast of Otago, confirms me in the opinion that our present Fur Seals belong to one species, *Arctocephalus cinereus*, which is distinct from the Fur Seal of the island groups lying further to the south, such as the Auckland and Campbell Islands. However, in Dr. Haast's collection of bones from Sumner Cave, which is perhaps one of the most ancient kitchen-middens that has been examined, I found the skull of this more southern species, which resembles *Arctocephalus lobatus*.

The discovery of a second specimen of a skull of the great Elephant Seal among the sand-hills south of Hokitika—the first specimen having been obtained in Otago—is another instance of the modern extinction of a southern form of seal in these latitudes.

In our ichthyology several very important additions have been made. The valuable communication by Captain Hutton added many new species of fish to the fauna, and already material for a still further addition has been obtained for the Museum.

The successful introduction of Salmon during the past year is a subject of great importance, although the experiment was not successful on so large a scale as was anticipated. Still, it has been proved that the ova can be brought out uninjured, even when submitted to hardships and delays that are quite unnecessary under a properly-organized system. For my own part, as I urged many years ago, I should prefer to see the experiment tried of obtaining the ova, not only of salmon, but of trout, white fish (*Coregonus*), and other species that inhabit the inland waters of British Columbia, in preference to shipments from Britain. The argument that the flavour of the West American salmon is inferior should not have any weight, when we remember that the salmon of every river has its peculiarity in this respect, and that nothing is more easily affected than the flavour of a fish according to the food upon which it lives.

The catalogues of the Marine Mollusca and the Star-fish of our coasts, prepared by Captain Hutton, will be found invaluable to collectors; but the most interesting contribution to the zoology of New Zealand is Captain

Hutton's essay on the geographical relations of its fauna. In this paper the author traces the relationship of the representatives of the different orders of animal life with those of other countries, and arrives at conclusions respecting the geographical relations and changes in outline during past times of the area of which New Zealand forms part. Whatever difference of opinion there may be respecting the more theoretical deductions in this paper, there can be no question about the immense industry and research which it displays. To some extent the conclusions arrived at support the speculation on which I entered in my last address, that the peculiar insular character of the forms of life in New Zealand have been preserved from a very remote period. But on this subject I am still of opinion that the evidence to be derived from the recent and fossil botany of the country should have much greater weight than mere considerations of the fauna. The investigation of the southern ocean by sounding and dredging, which is to be performed by the scientific staff now on board H.M.S. Challenger, will add so many new facts relative to this subject that it is premature to discuss it at present; but it behoves us in these colonies to use the utmost diligence in the collection of facts that will assist the eminent naturalists belonging to that expedition in making the most of the short time which has been allotted in their programme for their examination of this area. The collection which our Museum contains will, no doubt, be scrutinized with keen interest, and the more ample material we can obtain for their inspection, the greater advantage will the colony receive from their reports; moreover, collections of even the most common objects of natural history will be welcome additions to their stores, which are being formed with the special purpose of obtaining accurate information respecting the geographical distribution of species.

As relating to the study of the South Pacific Ocean, and especially its meteorology, I must call the attention of members to the magnificent charts recently issued by the Hydrographic Office, copies of which have been presented to our library by our distinguished honorary member, Admiral Richards. It is highly probable that the ensuing year will add to our knowledge of the great southern continent, which lies only 1,200 miles off, or at about the same distance as Melbourne from Otago. The little we know of this land is full of interest; its active volcanos, raising vast piles of scoria and lava streams amidst the perpetual antarctic snows, probably exercise a marked influence in producing the variations of our climate. There is a strong agitation in progress to have a party of observers stationed at Possession Island, on the coast of Victoria Land, in latitude 71° S., for a whole year prior to the transit of Venus, in December of 1874; and it has been justly pointed out that collateral observations in meteorology and magnetism, which the party would have an opportunity of making during this long period, would probably not be the least valuable and interesting results of the expedition.

New Zealand and the other Australasian colonies are directly interested in the successful carrying out of this proposal, and although the appliances required are quite beyond the means of the colony to supply, yet an expression of interest in the effort would greatly strengthen the hands of those who desire to see such an expedition organized. Merely as a commercial venture the further examination of the southern lands might lead to valuable results, on account of the extensive deposits of guano, which are described by Sir James Ross as having been forming for ages, and which, he surmises, may at some future period be valuable to the agriculturists of the Australasian colonies; and he also draws attention to the great extent of undisturbed whaling ground, in which whales of several different species abound in great numbers.

The paper by Captain Hutton, on the date of the last great glacier period in New Zealand, discusses a subject upon which there is room for great difference of opinion, owing to the complicated manner in which many subordinate questions have been mixed up with it. I gather that the author disagrees from the opinion expressed in my last address, that there has been a general subsidence of the New Zealand area, on a grand scale, during the post-pliocene or post-glacier period; and that, on the other hand, the whole evidence is in favour of elevation during the pleistocene period. His argument chiefly rests on the assumption that terraces prove elevation, but I may point out that, with reference to the Waikato basin, he asserts that it has never been elevated more than 50 feet above the sea, and yet its main tributary valley, the Waipa, has, according to Hochstetter, a most remarkable development of terrace formations.

But it appears to me that, with a general subsidence of the mountain centres, inequalities of movement are quite compatible, and in this way the elevation of post-pliocene marine deposits at Wanganui, which is in the centre of a great tertiary plain, affords no proof of the elevation of mountain masses at a distance of many hundred miles. The rigidity of the earth's crust, which such an argument would imply, is indeed quite opposed to Captain Hutton's own views in the lucid and thoughtful lecture on the causes which have led to the elevation of mountain chains, another valuable contribution by him to the current volume of the Transactions of the Institute. Unless palæontological evidence of a more recent period can be obtained from strata occupying valleys that were eroded during the last extension of the glaciers, I must still adhere to my formerly-expressed opinion, that the geological period previous to that which may be termed the recent period (not to be confounded with the very short "human" period in New Zealand) was characterized by a prolonged, though perhaps not excessive, elevation, and that, especially in the South Island there is, in consequence, a marked absence of marine drifts and tills, and that the subaerial deposits and fluviatile drifts of the former period still remain

resting undisturbed on the surface of the country. The extension of this period of elevation back into pliocene times, which the author suggests, I am quite willing to concede, if subsequent examination of our fossiliferous deposits should prove the existence of a sufficient break between our pre-glacier marine fauna and the existing fauna of our coasts.* But much has still to be done before any decision on this point can be arrived at. The arguments which affect the question can only be given in the form of detailed descriptions of particular localities, as general arguments on such a subject, where the elements of proof are derived from different and often distant areas, cannot be received as conclusive. I recommend the subject of the study of our soils, surface drifts, and beach rocks to the members of the Society, and will take an early opportunity of communicating the results of observations that I have made on this subject during past years.

With respect to the subject of glacier drifts and the formation of rock-bound basins, on which we have also a very interesting paper by Captain Hutton, and with whose conclusions I, in the main, agree, there is still a wide field for observation. The estimate I have been led to form of the rapidity with which a mountain ice-cap performs its work of eroding the elevated rock-mass into ridges and peaks is, however, very different from that of Captain Hutton. After the first rough excavation has been performed, and only the hard cores of crystalline or tough metamorphic rocks have survived the denudation, and when the valleys have all been perfectly moulded to perform their functions as ice-gutters, then I grant that the process of waste is very slow. Such a state of things may be found in many mountain ranges, and there the glacier ice is generally characterized by its purity of texture and its comparative freedom from *dêbris* resting on the surface. But in the New Zealand mountains, especially those culminating in Mount Cook, which are formed of rock masses of the most friable kind, such as crumbling schists and slaty sandstones cleaved and jointed in every direction, that causes them to break down with such facility, there, we learn from Dr. Haast, that the ice of the glaciers is hardly recognizable underneath the lode of fine *dêbris* by which it is covered, indicating the enormous erosive action which is in progress.

Owing to the softness of the rock that forms many of the narrow ridges which constitute côls, which I have examined in this mountain district, these heights are being rapidly cut through and lowered at the rate of many feet in a year; and, in several instances, true passes of low altitude exist, which show evidence that they have been formed at a very recent period by this process. The rapid change in the extent of the snow-line of the New Zealand mountains is also very remarkable. Thus, owing to the prevalence of dry winds during the past

* The original application of the word *Pleistocene* included *Upper Pliocene.*

two years, the summer snow has greatly diminished, and a corresponding diminution has taken place in the supply of ice at the terminal faces of many of the glaciers. Within the last few months a great change is reported to have taken place in the outline of the summit of Mount Cook, owing to a great avalanche having slipped from the ridge, which leaves a conspicuous gap in the formerly even, tent-like form of the apex.

As I have stated that I agree in the main with Captain Hutton's views respecting glacier action, I may be permitted to explain, without entering on a controversy, that I was the first to describe the formation of the Wakatipu Lake as a clearly-marked example of glacier erosion, in my report to the Provincial Government of Otago, in 1864; and that, at the same date, Mr. M'Kerrow—to whom Captain Hutton attributes the idea, as if it was opposed to my views—reported that the problem of the manner by which these lakes had been formed still required solution, and made no allusion to any ice action having taken part in their formation.

I must refer to the volume of geological reports for the progress which has been made during the past year in the survey of the country, and may state that the descriptive catalogues of fossils from the tertiary formations, and also an illustrated work on the fossil plants from the different coal-bearing formations, are now far advanced towards publication. The development of the wonderful Reptilian fauna in our upper secondary rocks will be communicated to the Society during this session. Already at least seven distinct forms have been worked out from the blocks of matrix collected at the Amuri Bluff and at the Waipara, and these gigantic Saurians will be sure to excite great interest in the study of the geological structure of this country, and, by exciting discussion at home, will indirectly attract attention to its mineral and other resources.

The only papers contributed to the Institute on purely chemical subjects emanate, as usual, from Mr Skey. In them I find that the author has continued his researches into the formation of native gold, and he begins his description of the results of these by combating the idea that gold is precipitated from solution only by organic matter. He then proceeds to describe a method of producing alloys of gold with silver by a "wet process," and thereby removing one of the great objections which has been urged against the hydrothermic formation of auriferous veins. In these experiments the solutions and re-agents employed were precisely such as were known in lodes that traverse rock masses, and he therefore maintains that our native gold alloys, which are so largely developed on the Thames Goldfield, have been produced by this method. Another paper by Mr. Skey is devoted to the discussion of the origin of large gold nuggets in drift formations; and, by a series of experiments, has confirmed the view first hazarded by Mr.

Selwyn, on geological grounds, that the nuggets occurring in such situations have been formed *in sitû* by the aggregation of gold by precipitation from solutions permeating the drifts.

Mr. Skey, in other papers, suggests an improvement in the process of the manufacture of iodine, and shows an absorptive power which clay possesses for strychnia and other alkaloids, which he traces to the action of silica in combining with these alkaloids.

I have thus shortly touched on the principal subjects to which the work of our Society has been directed during the past session, and it now only remains for me to thank you for the courtesy and support which I have received during the period for which it has been my duty and pleasure to preside at your meetings.

Dr. Hector then vacated the chair, which was taken by Mr. W. T. L. Travers, F.L.S., in the unavoidable absence of the President, Mr. Charles Knight, F.R.C.S.

1. "On the Occurrence of *Selenium* and *Tellurium* in the Neighbourhood of Wellington," by W. S. Hamilton.

The publication of this paper is deferred at the author's request.

2. "Notes on Dr. Hector's paper on the Whales and Dolphins of the New Zealand Seas," by J. E. Gray, Ph.D., F.R.S., Hon. Mem. N.Z. Inst. (*Transactions*, p. 93.)

3. "Notes on the Fixing of Sand-hills," by William Keene. Communicated by J. C. Crawford, F.G.S.

During the year 1867 Captain Benson, late chief manager of the P.N.Z. & A. Royal Mail Company, kindly undertook to make some enquiries for me as to what was done in Australia with regard to fixing sand-drifts. The result was the able and suggestive letter bearing the signature of William Keene, and given below. I suppose the writer to be Inspector of Mines to the Government of New South Wales, and a person whose opinion has weight.

From my experience in the matter, I quite agree with Mr. Keene that, at all events when a fixing of the sand is to be produced within a reasonable time, the means which he suggests are those which should be adopted as being rapid and effectual. On the other hand we must not despise the grasses. I find that I can break up and transplant the *Ammophila arundinacea* (*Marram*, English; *Oyât*, French) during all the damp months of the year, say from March until October; whereas in New South Wales the term for transplanting must be much more limited.

I have now spread this grass over a number of acres, and although I cannot say that it has fixed the sand, inasmuch as there are many more acres adjoining from which the sand blows over the plants, yet it begins in a way to alleviate the nuisance. The plant receives a drift of sand like manure, and grows above it, gradually attaching to itself a small sand-hill, but the process is extremely slow, and requires constant attention. Where the sand is blowing away the plants are apt to be blown out, and require to be watched and transplanted. Where the sand is accumulating the plants

grow vigorously, unless the increase of sand is so rapid as to cover them entirely, in which case they are unable to recover themselves, and appear no more.

In moderately-sheltered positions, however, where the sand is only blowing slightly, the *Ammophila* can be planted out with very slight loss of plants.

From the expense of enclosures it may be impossible, for years to come, to adopt the pine plantation system in many localities where the grasses may, in the meantime, prove very useful.

One great advantage of the *Ammophila*, as a sand-fixing grass, is the ease of transplantation, one plant of it broken up may give some hundreds to plant out.

The New Zealand plants *Cyperus ustulatus* and *Spinifex hirsutus* are both excellent for fixing sand; but, after repeated attempts, I have only succeeded in transplanting two or three of the former, and, I think, none of the latter plants. My attempts with seed have been equally ineffectual.

Lawson, of Edinburgh, recommends the seeds of *Ammophila* and *Elymus* to be puddled up with wet clay and short pieces of straw rope before sowing. No doubt this is an excellent plan, giving the young plant something to hold on to until it gets its roots established. But the success of *Ammophila* must, I think, mainly depend upon close attention to planting it out during the damp season.

"Newcastle, N.S.W., 15th July, 1867. Dear Sir—In attention to your request that I may give you any information I may possess on the best means of stopping sand-drifts, I may, in the first place, remind you of the fact that a great deal of money has been spent here at Newcastle in attempting to stop them, by sowing and planting grasses, and that all such attempts have failed.

"I recommend, from personal observation and knowledge of the mode of stopping the march of the sand-dunes on the sea-board between Bordeaux and Bayonne, that the same means should be employed which have there been so uniformly successful, and are as follows:—

"Spaces along the sea-board above high water mark are hurdled in with close hurdles, about 4 feet 6 inches in height, forming squares of not more than 10 yards each way. In these spaces the seed of the maritime pine is sown, so that the young plants come up almost as thick as wheat. As they grow in strength year by year, they are thinned out, and in their growth completely prevent the further onward march of the sand and break the strength of the well-known gales of the Bay of Biscay, and protect further plantations inland.

"By application to our Consul at Bayonne, Captain Graham, to whom I am well known, I am sure he would take the trouble to obtain a few boxes or hogsheads of the seed if the payment of the expense of so doing was assured to him, and, as we have frequent communication by ships from Bordeaux, Mr. Graham would send the seed to Bordeaux to be shipped for Sydney.

"This pine at full growth yields the resin which serves for sealing the wine bottles of Bordeaux, and the planks from which the cases for packing wine and brandy are made; also, abundant turpentine is distilled from the resin. The tree is, in fact, a profitable culture, and I recommend it as most certain of success.

"We have plenty of the bent grass growing here on the North Shore, but it does not prevent the spread of the sand.

"I can give you more particulars if they be desired, and remain, &c., William Keene.—To J. R. Pringle, Esq."

SECOND MEETING. 18*th August*, 1873.

J. C. Crawford, F.G.S., Vice-President, in the chair.

His Excellency Sir James Fergusson and about 30 members were present.

1. "Port Nicholson an ancient Fresh-water Lake," by J. C. Crawford, F.G.S. (*Transactions*, p. 290.)

The Hon. Mr. Waterhouse wished to know whether any fresh-water shells had been found, or any evidence of glacial action.

The author stated that fresh-water shells were mixed up with marine shells. He had observed no glacial marks.

Mr. George pointed out that in the borings for the patent slip at Evans Bay no shells were found deeper than 2 feet below the surface.

Dr. Hector described the character of the valley which descends from the Tararua Mountains, the lower part of which forms Wellington harbour, and said that he considered it a valley of erosion, and that there was no evidence of its ever having been occupied by the sea to a much greater extent than at present. Drifts belonging to earlier valley systems are to be found up to 1,000 feet above the sea, but only on the west side of the harbour. The destruction of these showed that the harbour basin had been, at all events, greatly widened, if not also excavated, since these drifts were formed, and there was no reason to suppose that they, or any of the subsequently formed deposits that skirt the harbour, were of marine origin. Except the slight rise of the shore-line in very recent times, the most evident change has been the erosion by the sea of the ancient barrier across the outlet of the harbour. This was, no doubt, assisted by inequalities in the movement of the parallel ranges among which the harbour lies. Such inequalities of movement have actually been observed within the last thirty years, and their tendency appears to be to throw the outlet of the valley towards the east. He, therefore, on the whole, was inclined to agree with the author of the paper.

Captain Hutton agreed with the author that the harbour had been hollowed out by sub-aerial denudation, but there was no evidence that it had ever formed a lake. The pleistocene beds, on which a large part of Wellington was built, were distinctly stratified, and therefore must have been deposited in still water; but they rose to a height of 150 feet above the sea level, and were continued uninterruptedly across to Island Bay. Wellington harbour had, therefore, geologically speaking, three openings, viz., the present entrance, that between Evans and Lyall Bays, and that from Te Aro to Island Bay. But no lake can have more than one opening, consequently the pleistocene beds of Thorndon, Te Aro, and the cutting going down into Evans Bay, must be either marine, or else they must have been formed in a lake in which Mount Victoria and Miramar Peninsula stood as islands. The latter

supposition would necessitate the subsequent total removal of the barrier from Cape Terawiti to Pencarrow lighthouse, which must have existed to form the lake. This could not have been removed since the period in which Mr. Crawford supposed that the harbour existed as a lake, and if therefore it had ever been a lake it must have been at a much more remote period, probably not later than the lower eocene.

Mr. W. Travers attributed the boulders mentioned by the author to ballast for canoes. He had observed no trace of glacial action in the district, and it was impossible for him to conceive why the appearance of the action of ice should be absent if it was to that that the excavation of the harbour was to be attributed.

The Hon. Mr. Mantell thought that more facts were required to prove the correctness of Mr. Crawford's views. Sir Charles Lyell had collected many interesting facts regarding the effects of earthquakes in this district. He might mention, as an additional fact, that in 1855 a fence in the Wairarapa lying north and south had all the rails drawn from the mortise holes, while one lying east and west had remained uninjured.

The author considered that a glacier did pass down from the Hutt. He did not think there had been an outlet to Island Bay, but that the original outlet was through Evans Bay. He agreed that a lake generally had only one outlet, but that meant one at a time. There is no reason why lakes may not have had different outlets in different periods.

2. "On *Cnemiornis calcitrans*, Owen, showing its Affinity to the Lamellirostrate Natatores," by James Hector, M.D., F.R.S. (*Transactions*, p. 76.)

The skeleton, on which the author founded his paper, was exhibited.

The Hon. Captain Fraser, who discovered the bones, gave some interesting information regarding the locality where they were obtained.

3. A letter respecting the Recent Change in the Apex of Mount Cook, received from Mr. Edmund Barff, was communicated by Dr. Hector.

"2nd July, 1873.—When I visited the southern parts of Westland in your company several years since, you remarked, on one occasion, that if ever a favourable opportunity should present itself for making the ascent of Mount Cook, an effort should be made to explore the mountain. It appears to me that there is such an opportunity at the present time. There has been an immense landslip on the south-western side of the peak, which appears to have originally covered a surface of at least a mile and a half in diameter, and which, viewed through a telescope at this distance, is seen to be scattered over the side of the mountain in immense irregular masses of rock. The slip occurred three weeks since, and it is a somewhat strange circumstance that the miners who are working in close proximity to the Francis Joseph Glacier heard no sound

which led them to suppose that any unusual event had happened. It was observed, however, that the boiling springs which were situate near the glacier suddenly ceased playing, and afterwards found their way to the surface at a distance of a quarter of a mile from their old position. This appears to indicate that the pressure caused by the slip was almost inconceivably great, and that the mass of rocks detached from the mountain is also very great. I may mention that the peak appears to be almost undermined at the place where the slip has occurred. Although the season of the year appears to present considerable, if not insuperable, obstacles in the way of anything like a thorough exploration, I deemed it advisable to communicate the above facts to you, as the circumstances to which I have alluded are, to say the least of them, at all events a little outside the limits of the ordinary changes which are going on over the surface of the earth in this part of the world. Should you require further information, I do not doubt that in the course of a few days I shall be in possession of further particulars."

4. A letter from Mr. W. H. Ralph, regarding a Hot Spring in the Bed of the Wataroa River, Westland, was communicated by Dr. Hector.

"4th August, 1873.—Some three weeks ago I was, along with two other men, out prospecting in the Wataroa River—the right-hand branch—when, about fifty miles up it from the sea beach, we came across a hot-water spring. It was situated in the bed of the river—the right-hand side—and the gas was issuing through the water among the rocks, causing a great bubbling. It was strongly charged with sulphur, and we could smell the noxious vapours for over a mile round. I am writing this under the impression that it may at some future day benefit science; or, should an eruption occur at any distant date, it may be known to exist. We intended to have brought down along with us a billy-full of the water on returning, to have it analyzed, but found, on going further up the river, that the other side was far better travelling, so we forded, and missed the opportunity. I may be allowed to add that it was a very bad road to travel, it taking us sometimes a day to go a mile or two."

5. "Notice of the Occurrence of a Red Spider among the Fruit Trees in the South, and the Disappearance of the Blight," by James Morton, communicated by Dr. Hector.

"I have made a discovery this season amongst fruit trees. The *Aphis*, or Apple Blight, I find, is suppressed or held in check by another minute race of insects, apparently a species of Red Spider (*Acaridæ*). These small insects completely cover the under parts of the branches, like a red rust, and wherever they make their appearance the apple blight does not exist, so much so that trees that I knew to be badly infected with the apple blight six years ago, and largely warted from its action, are now partially clean and this species of Red

Spider is occupying its place, the blight existing on the extremities of the branches. Of course I have not actually seen this species of Red Spider devour the *Aphis*, but this I say, where the Red Spider exists there is not an *Aphis* amongst them. They would require to be watched in an insect-breeding case, which I have not got at present. Should you feel interested in this, and desire me to send you a piece of branch with the Red Spiders on it, I will be glad to do so. I also find the Red Spider on plums and other trees which the *Aphis* does not inhabit, the trees apparently not suffering from any effects of this Red Spider."

Mr. W. Travers did not consider this spider to be a new discovery. It had been largely developed during the drought of last year, and the *Aphis* disappeared. He thought the spider was, if anything, the worse pest of the two.

A Bar of Iron, made from ore at Parapara, Collingwood, was exhibited by Dr. Hector, who described the locality and the nature of the ore.

THIRD MEETING. 1*st September*, 1873.

J. C. Crawford, F.G.S., Vice-President, in the chair.

About thirty-five members were present.

New member.—William Mouton.

1. "On the Formation of Mountains; a Reply to the Rev. O. Fisher," by Captain F. W. Hutton, F.G.S. (*Transactions*, p. 284.)

Mr. Carruthers, C.E., said he had great difficulty in seeing how arches of such magnitude could be supported in the manner pointed out, as they would rise, so far as he could see, in an irregular form. He also thought that the elasticity of the rocks would be sufficient to take up the pressure, unless the heat was considerable, say 200°.

2. "On a New Genus of *Rallidæ*," by Captain F. W. Hutton, C.M.Z.S. (*Transactions*, p. 108.)

3. "List of the *Algæ* of the Chatham Islands, collected by H. H. Travers, Esq., and examined by Professor John Agardh, of Lund," communicated by Baron Ferd. von Mueller, C.M.G., M.D., F.R.S., Hon. Mem. N.Z.I. (*Transactions*, p. 208.)

4. The chairman read the following communication, addressed by him to the Colonial Secretary, giving Suggestions for the conversion of Sawdust into Fuel.

"11th February, 1873.—I think that the suggestions given in the enclosed extract might be of advantage to the Government at a time of scarcity of fuel, such as exists at present.

There are immense accumulations of saw-dust adjoining every saw-mill in New Zealand, and if these heaps could be converted into good fuel, for steam or other purposes, by a mixture with peat or with coal-dust, a great gain would be achieved.

"Extract from 'Country Gentleman's Magazine,' of November, 1872.

"'The Duke of Sutherland is utilizing surface peat by making it into a composite fuel, and if this succeeds a great public gain will accrue to Scotland. The project had its rise thus. Mr. Forrester had a lot of sawdust lying in his way about the mill, when the idea occurred to him that if it could be cemented together with peat it might be converted into good fuel for his engine. He, therefore, prepared a plan of a machine to do the mixing, and submitted it to the Duke, who at once approved of it and suggested some improvements. They were adopted, the machine was set to work under steam power, and in a short time cakes of composite fuel were produced. It occurred to the Duke that if small coal or slack were used, as well as saw-dust, or without the saw-dust, a still better article might be obtained. This was tried, and with promising results. It is difficult to describe this process; but some idea may be formed of it when we state that the machine is erected on a large open space near the mass. It has a shaft nine feet long. From the centre to the end, on which there is no journal, there are fourteen knives, with other knives set at right angles, which are turned at the rate of two revolutions a minute. The peat is thrown in, and, with the coal and saw-dust, soon comes out again in a mixed state, of sufficient consistency to be wheeled away to the drying ground, where it is put into a mould frame, prepared for the drying field, and racked. In the course of a week the cakes are ready for use, if the weather be fine, and then it is found that sixty of the sawdust peats are equal to one cwt. of best Sunderland coal, and cost 25 per cent. less money; while thirty of the coal composites are set down as of this strength and value. If the cakes can be dried by artificial means, and there seems no good reason why they should not be thus dried, there will soon be abundance of peat fuel in Scotland," &c., &c.

5. "Further Report on the Chemistry of *Phormium tenax*," by Arthur Herbert Church, M.A. Oxon., Professor of Chemistry in the Royal Agricultural College at Cirencester, England.—April, 1873. Communicated by the Hon. the Colonial Secretary. (*Transactions*, p. 260.)

Samples of Tobacco, in the leaf and prepared state, grown in Auckland, were exhibited by His Honour Mr. Gillies, who gave some explanation as to its growth and mode of preparation.

FOURTH MEETING. *22nd September*, 1873.

Captain F. W. Hutton, F.G.S., Vice-President, in the chair.

New member.—E. W. Lowe.

1. "Notes on *Delphinus forsteri*," by James Hector, M.D., F.R.S. (*Transactions*, p. 85.)

The Chairman pointed out the value of this paper, and said that this

Dolphin had not been obtained for description since the time of Captain Cook until now.

2. "Notes on the Glacial Period," by A. D. Dobson, C.E.

This paper was read by Dr. Hector, who made some remarks regarding it, and said that more exact information and sections were required before anything definite could be said on the subject. He considered that many of the auriferous alluvial deposits that rest on shelves at a high elevation, nearly parallel with and close to the coast, were left in this position by the erosive action of the sea destroying the seaward side of the valley in which they were originally formed. The cliffs, on the top of which they rest, must at least have been cut by the sea since these alluviums were formed. He, however, agreed with the writer in most of his conclusions.

The Chairman agreed with the author that the gravels of the Moutere Hills in Nelson were older than the glaciers, but the Canterbury Plains could be proved to be younger than them. At Motanau, on the East Coast, a raised beach with recent marine shells occurred at an altitude of more than 100 feet above the sea, while at the mouth of the Conway the raised beaches attained an altitude of 300 feet. He had never visited the West Coast, but Mr. Hacket had described the moraines at Okarito as being rudely stratified, and containing rounded boulders of granite, while at a height of 200 to 300 feet above the sea they were all levelled at the top. This could only be due to marine action. He could not agree with Dr. Hector that the beach terraces on the West Coast were valley terraces, one half of the valley having been washed away by the sea, because he thought that rain would have removed the terraces before the sea could wash away the other half of the valley.

3. "On the Spread of *Cassinia leptophylla*," by W. T. L. Travers, F.L.S. (*Transactions*, p. 248.)

4. "On some New Species of New Zealand Plants," by John Buchanan, of the Geological Survey of New Zealand. (*Transactions*, p. 241.)

5. "Notes on the New Zealand Wood-hens (*Ocydromus*)," by Captain F. W. Hutton, C.M.Z.S. (*Transactions*, p. 110.)

6. "Notes on some New Zealand Fishes," by Captain F. W. Hutton, C.M.Z.S. (*Transactions*, p. 104.)

7. "An Introduction to the Study and Collection of the Araneidea in New Zealand. With a Description and Figures of *Cambridgea fasciata*, L. Koch, from Chatham Island; and also of a New Species of *Macrothele*, Auss., *M. huttonii*, Cambr., found at Wellington, New Zealand," by the Rev. O. P. Cambridge, M.A., C.M.Z.S. (*Transactions*, p. 187.)

The first part only of the paper was read at this meeting.

8. The following letter from Baron von Mueller was read by Dr. Hector:

"While working on Restiaceæ I revised also the few New Zealand species, and found that the supposed third species of *Calostrophus* is a new *Lepyrodia*, by which means your flora gets a new and interesting genus. Unfortunately Mr. Travers brought only male flowers. Can you kindly see whether, in your set of this plant, perhaps female specimens with capsules occur. Or, failing this, would Mr. Hunt, or any other settler, procure the female plant, which is easily found, as the species is conspicuous and probably common. I fancy, that still other Restiaceæ exist in New Zealand territory, and I would beg much that you will be so kind as to secure for me early samples, also any Cyperaceæ. They will then be utilized by me, while I go on with the elaboration of the Glumaceæ for the 7th vol. of the Australian flora. I shall, also, during this elaboration, attend to all the Glumaceæ from the Chatham Islands. The issue of a separate publication on Mr. Travers' last plants is an impossibility here now. So I will send any manuscripts thereon from time to time on to yourself. As soon as I get the female flowers of the *Lepyrodia* I will send a diagnosis for publication in your new volume. It may interest you that the *Calostrophus elongatus* of New Zealand has to change its name, as it is quite distinct from Labillardière's original plant. I have only this month recognized the true plant, gathered nearly 80 years ago by Labillardière in the south of Tasmania, and only (until now) known by his plate. As R. Brown has named the *Calostrophus*, common in Australia and New Zealand, *Restio lateriflorus*, I have given your plant the name *Calostrophus lateriflorus*. The genus is widely different from Linne's *Restio*, and belongs to the nucular, not the capsular, tribe of the order. All Glumaceæ for accurate diagnosis should have perfectly ripe fruits."

Fifth Meeting. *13th October*, 1873.

Charles Knight, F.R.C.S., President, in the chair.

About fifty members were present.

New members.—George Hall, George Thomas.

Publications received since last meeting were laid on the table.

The President said he regretted having to announce, on the first time of his taking the chair, the death of the Rev. Richard Taylor, F.G.S., a member of the Society, who had been from a very early period in the settlement of the Colony such an indefatigable worker in the cause of science.

1. "Notice of a Variation in the Dentition of *Mesoplodon hectori*, Gray," by James Hector, M.D., F.R.S. (*Transactions*, p. 86.)

The specimen on which the paper was founded was exhibited. It was found on the beach at Kaikoura by Mr. J. R. W. Taylor, and was presented by him to the Museum.

2. "On the Fossil Reptilia of New Zealand," by James Hector, M.D., F.R.S., Director of the Geological Survey of New Zealand. (*Transactions*, p. 333.)

Specimens illustrating this paper were exhibited.

3. "Description of the Patent Slip at Evans Bay, Wellington, and of the mode of erecting or constructing the same," by J. Rees George, C.E. (*Transactions*, p. 14.)

The author illustrated his paper with a large number of drawings and sections.

Mr. O'Neill, C.E., and Mr. W. Travers complimented the author on the able and successful manner in which this work had been carried out, and said it was a credit to the Province, and the paper would prove of great use to engineers.

4. "On the Extinct Glaciers of the Middle Island of New Zealand," by W. T. L. Travers, F.L.S. (*Transactions*, p. 297.)

Dr. Hector said that one cause for the former greater extent of the New Zealand glaciers appears to have been lost sight of in recent discussions on the subject. He had pointed it out to Sir Charles Lyell, who mentions it in the last edition of his "Principles," and also applies the same idea to the European Alps. The theory was that the elevation of the New Zealand mountains was probably coincident with the submergence of the low land in the interior of Australia, which is covered with a post pliocene marine formation. The equatorial north-west winds would thus impinge on the New Zealand Alps without, as at present, being deprived of a large amount of the aqueous vapour by passing over the arid plains of Australia, and by the condensation of snow by the mountains, would be therefore very much in excess, and consequently the glaciers much larger than at present. According to this view the true place to seek for evidence of the age of the glacier period in the Alps of East Australia and New Zealand is in the interior of Australia. A slighter degree of change at a later date must also have been due to the destruction of a large forest growth in Australia by fire, during the early period of its occupation by those we now call the aborigines, which is rendered probable by the circumstances under which the *Diprotodon* and other extinct and gigantic Marsupiates are found, and such a change must also have exercised an indirect influence on the climate of New Zealand. He differed from Mr. Travers' explanation of the phenomenon of Lake Guyon, as he considered it to be a portion of a valley that had existed prior to the

scooping out of the valley of the Dillon, and gave instances to show that the rapidity of the destruction of mountain ranges and the excavation of valleys was much underrated. The cutting through of a very slender mountain ridge or côl was frequently the cause of changing the whole drainage system, throwing immense bodies of ice in a new direction, and completely cutting off the supply from former valley channels. He thought, in every case, that the glaciers thus cut off from supply had remained in the lower part of the valley till an immense quantity of shingle had passed over them, and on melting left the deep lake hollows. The cutting through of côls was the origin of most of the lower passes.

Sixth Meeting. 24*th November*, 1873.

Charles Knight, F.R.C.S., President, in the chair.

About fifteen members were present.

New members.—H. Eustace Brandon, J. D. Baird, C.E., Charles Godfrey Knight.

Mr. J. C. Crawford, F.G.S., was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with Clause 7 of the New Zealand Institute Act.

The nomination for the election of Honorary Members of the New Zealand Institute was made in accordance with Statute IV.

1. "Descriptions of some New Zealand Lichens, collected by John Buchanan in the Province of Wellington," by James Stirton, M.D. Glasgow; communicated by John Buchanan. (*Transactions*, p. 235).

Seventh Meeting. 16*th January*, 1874.

Charles Knight, F.R.C.S., President, in the chair.

New members.—W. H. Jones, Charles Hepburn Robson, James Nelson Williams, George Henry Davies, William Brown.

1. "Notes on a Visit to White Island, in the course of a trip made in H.M.S. 'Basilisk,'" by the Rev. William Sewell, M.A.

(Abstract.)

The author's party landed, with some difficulty, at the only entrance to the hot sulphur springs. After going some way they reached the great central lake, which appeared to be some 700 yards or more in circumference. He

referred to the visit of Dr. Rolston and Lieut. Edwin, in 1868,* and the illustration by the Hon. J. C. Richmond, accompanying their paper on the subject; and said that there must have been a considerable change in the features of the lake since the visit of Dr. Hector, in 1870,† the water appearing to be at its lowest ebb, and, in the great geyser, but little of anything above the level of the sea. Much ground was traversed that in 1866, 1868, and 1870, was covered with water. Care had to be exercised, as the ground was very rotten in places. Once the author sunk to the knee in lukewarm sulphurous water. From the great geyser rose huge volumes of smoke above the height of the surrounding hills, and, as every now and again a breath of wind drove the smoke on one side, there was seen, some 50 feet below, a seething mass of boiling water. Judging from the varying depth and extent of the lake, as seen at different times by Dr. Rolston, Lieut. Edwin, and Dr. Hector, the author thought that there might be some subterraneous communication between the lake and the sea. "There is a dismal, dreary look pervading the whole place. The grim, barren hills rising high up on all sides, with here and there a little jet of steam issuing from some crevice at different heights, even to the very summit of the hills; and through the smoke little glimpses of the blue vault of heaven, the only refreshing relief from the dreary, dismal, awful hole of boiling sulphur below; while far away to the back stretches a broken surface of yellow sulphurous substance, with jets rising here and there, the view again closed by the dreary, barren hills, for the landing place is not visible from the great geyser." The author considers White Island one of the greatest curiosities of these shores, equal in wonder, though by no means in beauty, to the terraces of Rotomahana.

Dr. Hector gave some interesting information respecting the formation of the island, and its geological features.

2. The following letter, from Mr. T. H. Cockburn Hood, F.G.S., respecting the caves in Otago where the skin, neck, and feathers of a Moa, and remains of other birds, had been found, was read by Dr. Hector:—

"2nd January, 1874.—I had an opportunity lately of visiting the place where the man found the skin with the feathers of the Moa which you have in the Museum, and am quite convinced that it could not have lain there any great number of years—at all events in the spot where he got it.

"The cavern, formed by the sliding down of a mass of rock, has two main entrances. It is about sixty feet deep to the lowest accessible floor, and there is a narrow fissure leading down to a lower chasm.

"After digging down about a foot, at the very lowest part, in the soft *débris* of animal matter, droppings, etc. (not particularly dry), I found numbers

* Trans. N.Z. Inst., Vol. I., p. 57. † Trans. N.Z. Inst., Vol. III., p. 278.

of bones of small birds—paradise ducks, wekas, etc.—in excellent preservation; *above* them many remains of Moas.

"Dr. Haast wishing to have them, I left them with him. Their only value, I consider, is as evidence that the Moa remains are also very recent, as it seems impossible that such tender bones could have been preserved in this situation for any great lapse of time. Dr. Haast, however, does not agree in this. It must be remembered that the floor of the cavern is not always dry, as supposed; during thaws and in violent rain storms there must be a good deal of water go down, as is evident from the drifted grass sticking to the shelving side of the lowest part of the chasm, evidently come in with water through the fissures. The dust does not consequently incommode one in digging, as usual in caverns where there is much accumulation of old animal matter. The flat ground near had probably been a favourite camping ground, from the quantity of droppings—which are, no doubt, those of the large birds—swept in by the wind, the draught into the cavern being very great, even when a light breeze is blowing. Dr. Thomson and I had good evidence of this.

"At times the Moas, taking shelter under the high rocks at the foot of which the fissure opens, may have slipped down in the snow drifts, which would accumulate there and hide the aperture, and, from its shelving nature as well as narrowness, it would be utterly impossible for them to extricate themselves. This seems to be the most probable cause of the abundance of the remains of the great birds in this place. There is no watercourse that could have swept them in. Certainly the entrance may have become smaller, and the floor may have gone down. Subsidences of masses of the rocks in these hills, from the effect of water, are no doubt constantly occurring; there are many great holes and caverns, but, as it is at present, an Emu once in this particular one could not get out. The skin that you have may possibly have lain for a long time in some higher dry ledge of the rock, and from thence fallen down to where it was lying on the first landing, where it must have been pretty damp at times. Captain Hutton had visited the place a few days previously, and Dr. Thomson showed me the head of a Tuatara they found.

"There is another cavern about 150 yards from this one, but it was impossible for me to get into it without a rope and assistance. I wrote to Captain Hutton to tell him of it, and perhaps the Provincial authorities of Otago will be liberal enough to allow a proper examination of these places to be made. It would require men to bring up all the *débris* in buckets, and sift it in the light. Lying in the position one has to do, at the bottom of the narrow, low hole, one cannot do much."

3. "On the teeth of the *Leiodon*," by Charles Knight, F.R.C.S. (*Transactions*, p. 358.)

Dr. Hector explained that the President's paper was written at his request, as a supplement to his own paper, read at a former meeting, on the Saurian remains lately discovered in the South Island. He had just received a letter from Professor Owen, who anticipated that these discoveries would be most important, as they will probably supply some missing links in the connection between the fossil Saurians found in various parts of the world.

4. "Notes on the Flora of the Province of Wellington, with a List of Plants collected therein," by John Buchanan, of the Geological Survey of New Zealand. (*Transactions*, p. 210.)

5. Dr. Hector read the following extract from a letter received from Baron von Mueller, relative to a plant from the Chatham Islands, described in "Fragmenta Phytographiæ Australiensis," LXII., p. 79, as *Lepyrodia traversii*, which further specimens have proved to be a new genus—

"Among the Restiaceæ last sent by Mr. Buchanan is a female specimen of the tall species peculiar to the Chatham Islands. Unexpectedly it shows this plant to belong to the nucular, not the capsular, series of the genera, among which its dispersion of flowers places it separate from any, except the South African genus *Elegia*; but, as it differs in various respects from all the specimens of that genus, and as we have no *Elegias* out of Africa, I have deemed it best to form a separate genus for the Chatham Island plant, and have named this new genus *Sporadanthus*. It holds precisely the same relation to *Leptocarpus* as *Lepyrodia* to *Restio*. Perhaps you will kindly insert a brief note to this effect in your next volume."

The annual general meeting, which could not be held owing to the required number of members not being present, was adjourned till Monday, 26th January.

Seventh Annual General Meeting. 26*th January*, 1874.

Charles Knight, F.R.C.S., President, in the chair.

About thirty members were present.

ABSTRACT REPORT OF COUNCIL.

During the session of the Society for 1873 seven general meetings were held, which were usually fully attended. At these meetings thirty-two different communications were read, which is short of the number in previous years, but they were chiefly of considerable importance, and gave rise to interesting discussions, so that the real amount of work done by the members of the Society is not below the average.

Nineteen new members have been added to the Society since the last annual

meeting, making a total of 149 members. The periodicals mentioned in last report are still taken in, and the following have been since subscribed for, viz.:—Annals of Natural History, Proceedings of Microscopical Science, and Philosophical Magazine.

The following works have been presented to the Library:—Thirty-five vols. of Dietrichsen and Hannay's Almanack, from 1838 to 1871, by Captain Edwin; thirteen vols. on various subjects, by Mr. W. Lyon; a complete set of the publications connected with the "Novara" Expedition, through Dr. Hochstetter; and a copy of Dr. Buller's "Birds of New Zealand," from the Colonial Secretary.

From the annual statement of accounts it appeared that the balance brought forward from last year was £95 10s. 8d. The subscriptions received amounted to £146 18s., and one life subscriber had paid £10. The largest items of expenditure were Gray's "Genera of Birds," one vol., £25 5s. 2d.; Bouchard, second payment for insects, £25 8s. 11d.; contribution to New Zealand Institute, £24 9s. 8d. The balance in hand was £107 14s. 8d.

Mr. W. T. L. Travers drew attention to the insects which had been purchased by the Society from Mr. Bouchard. When they arrived they were in very bad condition, but through the exertions of Mr. Gore they were now in a state fit for inspection, and formed a creditable collection.

Election of Officers for 1874.—*President*—Charles Knight, F.R.C.S., F.L.S.; *Vice-Presidents*—J. C. Crawford, F.G.S.; W. T. L. Travers, F.L.S.; *Council*—Dr. Hector, F.R.S., H. F. Logan, W. S. Hamilton, J. R. George, C. C. Graham, Commander R. A. Edwin, R.N., J. Blackett, C.E.; *Auditor*—Arthur Baker; *Secretary and Treasurer*—Richard B. Gore.

1. "On a New Species of *Rubus*," by John Buchanan, of the Geological Survey of New Zealand. (*Transactions*, p. 243.)

2. "On the Durability of New Zealand Timber, with Suggestions for its Preservation,"* by John Buchanan.

(abstract.)

The author remarked that in every locality some particular timber was specially lauded above every other, but that such opinion was seldom based on a general knowledge of our timbers. The very best kind may be rendered quite useless by cutting badly-selected trees at wrong seasons, and by want of proper treatment afterwards. Trees of less diameter than 18 inches contain a large amount of sap, and, consequently, are not durable. The proper time to cut them is in winter, when the sap does not circulate. But the winter in New Zealand is so short and uncertain that a sufficient supply of timber could not

* Printed in the "Wellington Independent" of 29th January.

be cut during that season; therefore other methods of getting rid of the sap must be resorted to. In some parts of Great Britain, and notably in the Imperial Dockyards, the timber is "streamed," the running water washing out the sap, and being afterwards itself more easily got rid of. A less efficient plan is to stack the wood in such a way that it is exposed to the full benefit of the rain and wind. The kauri timber of Auckland is much improved by being floated down the streams to the place of shipment. When timber is placed in contact with damp earth decay can only be prevented by its infiltration with antiseptic fluids, or other preservatives. The totara (*Podocarpus totara*) is indebted to a secreted oil for its preservation. In the crude petroleum of Poverty Bay we possess an excellent artificial substitute for this natural secretion, and it therefore only remains to prove whether the renewal of timber every few years would cost less than the oil and its application. The permeating power of petroleum is very great. Either by painting the surface, or by infiltration, wood already in use might be made safe for many years. It may not be generally known that the application of kerosene will arrest dry rot. The author finished by pointing out that our present hand-to-mouth system can only be productive of short-lived buildings.

The Hon. Mr. Waterhouse said that the paper read did not nearly exhaust the subject. Certain seasons should be set apart for cutting timber. The very best heart of totara piles in his house were quite rotten after being only six years in the ground. A knife could be pushed into their very centre. Some timber at Castle Point also rotted at the base after six years. The timber had been cut in summer, and at once placed in the ground. Charring is a good preservative for wood in the ground, and manuka cut at the proper season and charred is preferable to anything; but if cut in summer it will only last a short time. Sleepers should always be charred. He hoped the matter would not be lost sight of.

2. "On Solar and Terrestrial Radiation," by C. Rous Marten, F.M.S.

(ABSTRACT.)

The author described the instruments employed in the registration of the solar rays, and the methods adopted by meteorologists to obtain readings. He then proceeded to point out that the solar radiation in the South Island attained a degree which was never reached in the North Island. In Melbourne, where the temperature usually ranged much higher than in New Zealand, the highest solar range registered during a period of 16 years was 160°. At the Cape and in Sydney the highest range was 140°; while, in the South Island, readings of 170° were frequently shown, and on one occasion in Southland the solar rays reached the extraordinary reading of 195°. The author said that he would read a fuller paper on the subject at a future meeting.

Mr. Travers was aware that the high readings spoken of by Mr. Marten

were on record, but it would be very interesting if Mr. Marten could place the meeting in possession of some explanation as to the cause of this peculiarity in the climate of New Zealand. Possibly the difference in the vegetation of the two islands might in some measure account for the different readings.

Mr. Marten considered the excess in the case of the South Island too great to be accounted for in this way.

Mr. Gore said he was sorry Dr. Hector was absent, as he was sure he would have a great deal to say on the subject of radiation. For his own part, he had long been aware of the facts stated in Mr. Marten's paper; indeed, they were known to everyone who had consulted the printed meteorological returns. It had always been a matter of surprise to him to find the solar radiation so much higher at some stations than at others, and especially strange that it should be higher in Southland than at most of the other places in New Zealand, and even greatly in excess of that recorded at Melbourne. He had hoped that Mr. Marten's paper would throw some light on the subject, and he was rather disappointed at not hearing some good reason assigned for such an excess of the solar radiation in Southland. He hoped that Mr. Marten would yet explain the matter, for until some cause could be set forth he was inclined to distrust such excessive readings of the black bulb thermometer.

The Hon. Mr. Waterhouse, before the meeting concluded, suggested that the Council of the Society should endeavour to popularize science by holding a *conversazione* periodically, at which short papers upon what he might call popular subjects would be read, and at which all classes, particularly the working classes, might be instructed and entertained by simple illustrations of scientific subjects, varied by the introduction of musical selections.

Mr. Travers remarked that as far as his experience went science was not at all popular in Wellington, and he did not think the course proposed by Mr. Waterhouse would make it so. Something of the kind suggested had already been attempted and had failed.

AUCKLAND INSTITUTE.

Annual General Meeting. 21*st May*, 1873.

T. Heale, President, in the chair.

New members.—M. Hannaford, W. Scott, H. M. Williams, A. Cox, C. B. Knorpp, C.E., J. Slatter, E. Thomas, R. Stockwell, M.D., W. J. Cawkwell.

ABSTRACT REPORT OF THE COUNCIL.

Seven meetings have been held during the year, at which twenty-one papers were read.

The number of visitors to the Museum has been larger than during any previous year. Considerable additions have been made to the Museum and Library, and also to the Herbarium.

In addition to the ordinary work of the Institute, considerable assistance has been afforded to the public in the identification of minerals, birds, insects, and plants, affording proof of the readiness of a small section of the community to avail itself of a portion of the advantages offered by the Institute.

The Council believe that much of the interest manifested in scientific pursuits is due to the annual volume of "Transactions." They would also call attention to the Natural History Catalogues, issued by the Geological Survey Department, and have especial pleasure in recording the efforts being made to establish classes for the study of certain branches of natural science in connection with the Auckland College and Grammar School.

The receipts for the year ending 19th May, 1873, amount to £280 4s. 8d., and the expenditure to £228 4s. 9d., leaving a balance of £51 19s. 11d. The expenditure includes, however, the expenses for three months of the current year. The subscriptions for the year amount to £187 19s.

Election of Officers for 1873.—*President*—His Honour T. B. Gillies; *Council*—J. L. Campbell, M.D., T. Heale, C.E., J. Stewart, C.E., T. Kirk, F.L.S., Rev. J. Kinder, D.D., D. Hay, H. H. Lusk, T. Russell, Hon. Colonel Haultain, Rev. A. G. Purchas, M.R.C.S.E., T. F. S. Tinne; *Auditor*—C. Tothill.

Resolved—That the thanks of the society be presented to the President and Council for their services during the past year.

Resolved—That the thanks of the society be presented to the Secretary, Thomas Kirk, Esq., F.L.S., for the zealous manner in which his duties have been performed, and that a separate record of this resolution be made on the minutes of this meeting.

SECOND MEETING. *9th June*, 1873.

His Honour T. B. Gillies, President, in the chair.

New members.—J. A. Pond, J. Anderson, L. D. Nathan, W. Goodfellow, F. J. Moss.

The list of donations to the Library and Museum was read by the Secretary.

The President delivered the following anniversary

ADDRESS.

In opening the sixth session of this Institute I cannot refrain from congratulating you on the progress and prosperity of our institution. When, six years ago, our first President (Mr. Whitaker) addressed you at the opening of the institution, he—notwithstanding the encouragement to be derived from the small beginnings of the Royal Society of England and the Academy of France, which he adduced—ventured only to express "a wavering hope," "rather than a belief," in our future career. And though in some respects our society has not attained to the usefulness to which its founders hoped it would have attained, in others it has, I think, exceeded their most sanguine anticipations. When I observe that our original 68 members in 1868 have now increased to 185; when I see that we stand first on the list of affiliated societies to the New Zealand Institute in point of numbers; when I observe that we stand second only to the central institution at Wellington in either the number or quality of contributions towards recording scientific facts, I think we have reason to congratulate ourselves on the success of our institution. Our contributors of papers have been fewer than I could have desired and, I think, fewer than they might have been, and the attendance at our meetings smaller than I had hoped for; nevertheless, the contributions to our Museum, and the numbers of visitors to it, prove that our efforts have not been altogether unavailing in maintaining and increasing an interest in the pursuit and results of physical science. Many of you, I doubt not, have planted shrubs and trees, the growth of which you have attentively watched, and, I doubt not, have observed that, as a rule, your short-lived shrubs have in growth rapidly outstripped your trees whose age can only be measured by centuries; that your long-lived trees take many years ere they put forth strong, vigorous shoots, and very many more ere they produce either blossom

or fruit. But, for all that, they are making meanwhile the underground roots, which will hereafter nourish and sustain them. And so it is, and I trust will be, with this society, that meanwhile, without much show or pretence, we are spreading out roots and preparing for the bloom and fruit of future years.

There is one thing, however, which is essential to the fair growth of any tree, however hardy and well adapted to its soil, namely, shelter. And I feel certain that the growing energies of our society must be rendered largely unavailing unless we obtain better shelter for our Library and Museum than we now have. We have already, in our Library, a large number of scientific works of reference, some of them, I believe, unique in the colony. We have specimens in various branches of science in our Museum, some of them unique, and others which could scarcely be replaced if destroyed, and yet these are not only comparatively valueless to the public and to the student, because of the inconvenience of studying them or referring to them, but are absolutely in constant danger of being swept away from amongst us by the merest accident, or of being destroyed by natural decay from the impossibility of properly preserving them. Had we a building suitable for a Library and Museum, in which scientific works and scientific collections and instruments could be deposited, we could, in addition to our existing treasures being safely kept, have, to my certain knowledge, several hundreds of volumes made accessible to students, and some thousands of specimens in various branches of science placed under their observation. It is to me lamentable to think that all these treasures should be locked up in the hands of and accessible only to a few, when, by a little exertion, we might render them accessible to all, by providing a building in which they would be safe and properly cared for. Such a state of things ought not to be in a community so large and so wealthy as this, and I trust it will not long be allowed to continue. For the sake of science, which we profess to love—for the sake of our society—for the sake of our successors—for the sake of our own credit and the credit of our Province—an effort, and a very strenuous effort, ought to be made by us to found, in some shape or way, a free public library and museum. We are possessed (thanks to the goodwill of my predecessor in office, as Superintendent) of an excellent and valuable site for such a building. The building is what we want. We cannot expect our Provincial Government, in its impoverished condition, to aid us to any considerable extent, as has been done to our sister societies in the South by their Provincial Governments, out of their plethoric land funds. We can hope for nothing from the General Government, for all that can with difficulty be squeezed out of the common purse is needed for (and, I will add, well spent in) the maintenance of the central institution at Wellington. We must, therefore, rely on our own energies, resources, and liberality. I would, therefore, invite some of our members to contribute designs for a suitable building, to

cost, say, from £2,000 to £3,000; and I would further invite others of our members to contribute various practical detailed plans by which the necessary amount might be raised. That it can be done I am convinced, if we only go earnestly and determinedly about it. We have, in fact, only to raise £1,000 in cash in order to obtain the remaining £2,000 at £120 per annum of interest, which, I believe, we could easily realize from rents of class rooms, lecture rooms, and proceeds of lectures, without interfering with the ordinary revenue of the society. Or we might, by combining with some kindred institution and uniting our forces, raise the entire sum required. I press this earnestly on your attention, for I believe that the present state of our Library and Museum has been a great hindrance to us in the past, and that a better state of these would be an immense impetus to us for the future.

In connection with the past of our own and kindred societies, permit me to invite your attention to the fifth volume of the Transactions and Proceedings of the New Zealand Institute, just published. In quantity and in quality it is equal, if not superior, to its predecessors, although I venture to think that it might be somewhat abridged without loss to science or loss of interest to general readers. There are eighteen papers on miscellaneous subjects, the first of which, on "The Life and Times of Te Rauperaha," will be found exceedingly interesting. There are nineteen zoological papers, some of them, in regard to the birds of New Zealand, of special interest; thirteen botanical papers, in which our worthy secretary stands pre-eminent; five chemical papers, all by Mr. Skey, of the Wellington Laboratory; and two geological papers, besides a summary of the proceedings of the various affiliated societies. It strikes me that chemistry and geology are, though ably, not so extensively represented as they might be if the votaries of these respective branches of science were to favour us with their contributions. And the absence of geographical and biological papers seems to me somewhat remarkable. The absence of biological papers may, no doubt, be fairly attributed to the hesitation which thinkers and observers on such subjects must naturally have in laying their thoughts and observations before the public in the present unsettled state of that branch of science; and yet that is just the state in which stray thoughts and observations may prove to be of the greatest value. The absence of geographical papers is less easily accounted for; for if there be one branch of elementary knowledge more than another in which we are defective in New Zealand, it is that of the geographical knowledge of our own colony. We have two, I think, small school books purporting to be geographies of New Zealand, but both miserably defective even where not positively erroneous. Our children are drilled into British geography rather than into that of their own native country, New Zealand. We find our newspaper editors constantly displaying the grossest ignorance of the geography of the colony, and they have no reliable book of

reference to guide them. Here, I think, is a department in which many of our members could give valuable contributions, which ere long could be built up into an authoritative and reliable geography of New Zealand.

It must, I think, be pleasing to you, as it is to me, to observe that—whether owing to the influence of our own and kindred societies or not I will not venture to assert—physical science is becoming rapidly recognized as a subject of even elementary education in the colony. Not only have we in the Otago University a Professor of Natural Science of no mean rank, but in several of the educational establishments affiliated to the New Zealand University there are lecturers on chemistry, botany, and other branches of physics. And it is pleasing to observe that popular lectures in some of our towns on scientific subjects are attracting attention and drawing audiences. These things point to the progress of the future, when the dry bones of history and thrice-threshed straw of logic and philosophy will give place to the study of things capable of proof—of physical science.

But here I desire to remind you and the public that we are not *merely* a scientific society. The terms "science" and "scientific" have become so much words of terror to those who fancy themselves outside of the pale that they either, on the one hand, hate or fear us as antagonists, or pooh-pooh us as enthusiasts. From their ranks, as well as from yours, I desire to enlist contributors to our proceedings, by reminding you that we are an artistic and literary, as well as a scientific, society. Science is of things we know—the provable; it deals with with what is cognizable by our senses or demonstrable to them, and with the deductions that may either necessarily or probably be fairly derivable from these facts, observable by, or demonstrable to, our senses. But man is not all sense, however much his other capacities may owe to or be dependent upon his perceptive faculties. Whether his mental powers or æsthetic feelings be or be not independent of his physical nature in their origin, we must recognize the fact that in many the pure mental or literary powers, in many others the æsthetic or artistic feelings, largely predominate over the purely scientific faculty—the desire to know and the capacity of knowing. And we must further recognize the fact that there is an influence, and a very beneficial influence, exerted upon the scientific tendency by the, to some extent, divergent literary and artistic tendency. As Professor Tyndall has so well pointed out, there is a great scientific use of the imagination—"that wondrous faculty, which, left to ramble uncontrolled, leads us astray into a wilderness of perplexities and errors, a land of mists and shadows; but which, properly controlled by experience and reflection, becomes the noblest attribute of man—the source of poetic genius, the instrument of discovery in science, without the aid of which Newton would never have invented fluxions, nor Davy have decomposed the earths and alkalies, nor would Columbus have

found another continent." So, also, of the artistic feelings—the love of harmony and the beautiful—they have a real scientific value. The popular collocation of art, science, and literature has more real substantial basis than we might be inclined at first sight to award it. In fact, like the popular instinct for beans and bacon, peas and pork, potatoes and beef, which Liebig shows to have certain real relative nutritive values, so the popular instinct which associates art, science, and literature unconsciously recognizes the fact that these have re-operative influences on each other, and that neither alone can well attain to perfection or develop its entire mental nutritive value without the other.

I therefore desire to remind you that literary or artistic contributions are not foreign to the aims of our society, that, indeed, they would tend to increase the interest in it, and relieve it from the opprobrium of dealing exclusively with what, to many minds, seem dry, dull things—namely, facts. Thus, I think, contributions relative to the mythology of the native race; anecdotes relative to the early settlement of the colony, or of those who took part in that great colonizing work; reviews of such works as Darwin's "Descent of Man," or his "Emotions," Maudsley on "Mind" and "Body and Mind," Bastian's "Beginnings of Life," Brassey's "Work and Wages"; or of such as Domett's "Ranolf and Amohia," the Earl of Pembroke's "South Sea Bubbles," Trollope's "Australia and New Zealand," or criticisms on the works of our New Zealand artists, suggestions for beautifying our domains or for utilizing our natural products, these and many other subjects would, I think, come within the scope of our society's constitution, and impart an interest and popularity to our proceedings. Not that I would court a popularity which would impair, but only that which might enhance our usefulness. For there is a solid value in popularity when allied to usefulness, although by itself it is a worthless element, and, when allied to that which is useless, even a mischievous thing. But believing, as I do most sincerely, that we are in this society doing quietly and unassumingly a good work for the community at large, we cannot, I think, too much endeavour to render our work and our objects popular as well as useful. It is one of the characteristics of the science of the present age, that it endeavours to make itself popular—that is, known to, understood by, and liked by, the mass of the people. We find that the profoundest scientific minds think it not beneath them to endeavour—as Tyndall, Huxley, and others do and have done—to educate the minds and enlist the sympathies of the people in and in favour of the great truths which physical science teaches; I say the truths which it teaches, for herein lies the grand power of physical science—its confidence in truth, its utter hatred of all that is untrue; its unwillingness to admit as truth that which is only a probability; its doubt and distrust of what is only a

possibility. And, feeling in itself, the power and necessity of truth, the scientific mind accepts no authority and subscribes to no faith which it cannot if necessary test and verify; whilst, on the other hand, it asks no acceptance for its own conclusions without their being thoroughly tested, both as to the reality of the facts on which they are based and the legitimacy of the conclusions themselves. What the ultimate conclusions may be we know not, and fear not, confident in this—that if true scientific processes be employed to test them, they must be either true, or the nearest approach to truth that we mortals can hope to attain to.

I thank you for your patience, and bespeak your indulgence for the hurried thoughts I have this evening placed before you.

1. "On the Geological Structure of the Thames Gold Fields," by Captain F. W. Hutton, F.G.S. (*Transactions*, p. 272.)

2. The following Report on, and Analysis of, the Water with which it is proposed to supply Shortland and Grahamstown, forwarded by Dr. Hector from the Colonial Laboratory, was communicated by His Honour the Superintendent:—

"27th May, 1873.—*Character of Water.*—Clear, tasteless; a slight sediment had formed, the character of which was not examined. The water, separated from this and analyzed, gave the following results, calculated upon a gallon of it:

"Chlorine	1·551
"Sulphuric acid	·354
"Carbonic acid	1·783
"Magnesia	·665
"Lime	·308
"Soda and potash	2·772
"Silica	2·857
	10·290

"Organic matter—the average of two determinations—2·1 grains per gallon.

"Amount of readily oxidizable matters per gallon, ·384 grains.

"The bottles enclosing samples being closed with corks, instead of glass, as should always be done, the results have not that degree of value they would otherwise have.

"The quantity of readily oxidizable organic matter is probably a little too high, as here given, owing to the presence of a little sulphuretted hydrogen in the water tested, from the cork having deoxidized a portion of the sulphuric acid present in the water, and for this reason the quantity of this acid, as stated in results, will be less than it really is.

"However, subject to these errors, the water proves to be of fair quality, but inferior to some waters for brewing purposes, owing to a deficiency of lime salts."

THIRD MEETING. *4th August*, 1873.

The Hon. Colonel Haultain in the chair.

New members.—H. Brett, J. Breen, B.A., Capt. Steel, J. Watt, H. Allwright, C.E., E. Waddington, M.D., G. Holdship, W. H. Kissling, R. Day, M.D., R. Millett, C.E., W. H. Clarke, H. Richmond, T. Kissling, J. Fairburn.

The Secretary read the list of donations to the Library and Museum.

The Secretary exhibited a specimen of damask table cloth woven from native-dressed *Phormium*, and read an extract of a letter from the Agent-General in England relative thereto.

Mr. D. Hay exhibited cones of *Pinus radiata* and *P. insignis* grown in the vicinity of Auckland, and made a few observations on the trees which produced them.

Mr. Kirk offered a few remarks on Captain Hutton's paper on the Geological Structure of the Thames Gold Fields, read at the last meeting.

Remarks were made by various members on the Analysis of Thames Water Supply, read at previous meeting.

1. "On the New Zealand Forms of *Cheilanthes*," by T. Kirk, F.L.S. (*Transactions*, p. 247.)

The paper was illustrated by specimens from the Herbarium of the Auckland Institute.

2. "Remarks on Dr. Bastian's recent work on the Beginnings of Life," by T. Heale.

(ABSTRACT.)

After giving an historical notice of the subject, the paper epitomized, at some length, the views maintained by Dr. Bastian as to the identity of vital force and ordinary physical force, and the impossibility of maintaining any sharp line of distinction between organic and inorganic matter; described the nature of colloids, and the behaviour of crystallizable substances in viscid fluids, as investigated by Mr. Rainey and Mr. Lewes, which showed how very similar some of the products of undoubted crystallizing forces may be to some of these formations from organic matter which are considered to be living organisms. The writer observed that it would be presumption to set up independent opinions here on such a subject; that we must wait till the "masters have spoken"; but, as a provisional hypothesis, the view forcibly struck him that since there must be a point in the chain of creatures above which life is only produced by germs or ova, this distinction must establish so sharp a line of division that it may be open to doubt whether the lower one should be considered as living at all. He noticed a great apparent want of continuity

in Dr. Bastian's experiments and reasoning: he had shown that Bacteria, occasionally forming films, were produced in his solutions boiled in vacuum tubes; and he then went on to show, with admirable clearness, the progress of development of higher organisms from Bacterian and Leptothrix films when placed in ordinary conditions. But he does not, as far as the writer can see, anywhere maintain that the films formed by him as described, in vacuo, will produce penecilium, euglenæ or paramecia, and ciliated infusoria, if only exposed to air which has been effectually deprived of germs; whence it might be inferred that Dr. Bastian admits the necessity of germs for these.

The paper quoted at length Professor Wyville Thomson's remarks upon the very lowest form of life, Bathybius, spread in an almost unbroken sheet under the whole area of the ocean, and suggested that this vast development of protoplasm everywhere—in every stagnant ditch, or under 15,000 feet of ocean—may be but the first link between organized creatures and inorganic matter, necessary to the existence and development of life, and consisting of very compound and, therefore, mobile molecules, built up by physical forces, and, though subject to very great and rapid changes, being in a constant condition of variation and molecular motion, yet not itself alive.

The paper went on to notice the great apparent difficulty, suggested by Dr. Bastian, in conceiving that these lower forms of life should have descended from a line of ancestry far more remote than any of the higher animals, and should still be as simple and rudimentary as at first; facts which he considers quite opposed to the principles of the Uniformitarian and Evolutionary Philosophy. It was maintained that, while the conditions remained such as could only maintain the most rudimentary forms of life, development must remain an impossibility; that when the conditions admitted of a higher form of life being maintained, there development had probably taken place.

The paper wound up with a few short observations on the importance of this subject, not for scientific purposes only, but as largely influencing the issues of health and disease, and a hope that the colonists of New Zealand would never so alienate themselves from the rest of the human family as to consider so vast a human interest foreign to them.

An interesting discussion ensued, in which many members took part.

Fourth Meeting. *8th September*, 1873.

The Rev. A. G. Purchas, M.R.C.S.E., in the chair.

The list of donations to the Library and Museum was read by the Secretary.

1. "On Cosmography," by J. Leith.

2. "On the Reclamation of Sand-wastes on the Coast, and the Prevention of their Inland Advance," by J. Stewart, C.E. (*Transactions*, p. 42.)

Remarks on the paper were made by Messrs. Mitford, Kirk, and others.

3. "On Induction and Necessary Truth," by the Rev. R. Kidd, LL.D.

Fifth Meeting. *6th October*, 1873.

The Hon. Colonel Haultain in the chair.

New members.—J. Wallace, J. Goodall, C.E., H. T. Kemp.

The list of donations to the Library and Museum was read by the Secretary.

A letter was read from Mr. Leith relative to his paper on Cosmography, read at the previous meeting.

1. "Remarks on Mr. Leith's paper on Cosmography," by T. Heale.

Dr. Kidd, Mr. Pond, and others spoke on the subject.

2. "On the most Economic Mode of Felting Steam Boilers," by J. C. Firth. (*Transactions*, p. 32.)

The paper was illustrated by a diagram and model. Messrs. Stewart, C.E., Lodder, Chamberlin, and others spoke in terms of commendation of the simplicity and efficiency of the plan brought forward.

3. "Notes on the Plants best adapted for the Reclamation of Sand-wastes," by T. Kirk, F.L.S. (*Transactions*, p. 45.)

A long and interesting discussion ensued, in which Messrs. Mair, Stewart, Firth, Knorpp, Hay, Goodall, and others took part.

Sixth Meeting. *10th November*, 1873.

The Rev. A. G. Purchas, M.R.C.S.E., in the chair.

New members.—His Excellency Sir James Fergusson, Bart., J. Martin, Major Green, S. B. Biss, J. F. Slowman, W. Drake, R. Whitson, C. E. Cook.

The Secretary read the list of donations to the Library and Museum.

1. The following Report on Samples of Stone from the Tokatea Tunnel, by Dr. Hector, was communicated by His Honour the Superintendent :—

"11th October, 1873.—On the 11th July, I learn from Mr. Aitken's letter and plan, that the length of the drive, which runs north-east and south-west, was on the west, or Coromandel side, 750 feet ; and on the east, or Kennedy Bay side, 250 feet, making a total of 1,000 feet, or about half the total distance which has to be driven. The drive is divided into sections of 100 feet in

length, and from each, what I presume to be an average specimen of the rock passed through, has been sent, together with samples of the reefs cut.

"*1st Section on West Side.*—A dark, very compact base, containing tabular crystals of felspar, and grains of a red mineral not determined. The structure is only visible in the heart of the fragments, which are weathered on the outside, of a mottled green, and dirty from earth.

"*2nd Section.*—Soft rock of a light buff colour, mottled as if formed by the decomposition of a felspathic paste, containing an imperfectly crystallized mineral.

"*3rd Section.*—Fine-grained breccia containing rolled pebbles of the tufanite rock in the 4th and 5th sections, and iron pyrites in small quantity; evidently a rock that has been decomposed.

"*4th Section.*—Compact white paste, speckled with blue spots, that have no defined shape, and containing much pyrites.

"*5th Section.*—Sharp granular rock of light grey colour, containing large quantities of pyrites in brilliant crystals and grains. This is the characteristic tufanite of the Thames Gold Fields.

"In this rock the first quartz vein was met with, lying very flat, the dip being 22° to south-south-east. Its thickness on the plan is stated to be 1 foot 6 inches, and its yield 19 dwts. per ton.

"The sample sent of the quartz from this vein showed distinct traces of gold, but the quantity was too small to be determined.

"*6th Section.*—Dark coloured, compact, heavy rock, containing much carbonate of lime and pyrites.

"This section is cut through at 560 feet by a quartz vein 6 inches thick, running north and south, with an easterly dip of 25°. The quartz is stated to yield 6 ozs. 10 dwts., but the sample received only gave traces of gold. After a short interval there is a second vein, 1 foot thick, with nearly the same dip, resting on a dyke said to be diorite, but no sample seems to have been sent. The vein-stone is calcspar, with druses lined with crystals of arragonite, and only containing small threads of quartz.

"*7th Section.*—Light coloured, calcareous, and pyritous rock. This is cut by a quartz vein 6 feet thick, and nearly flat, or with a slight underlay of one in twenty to east. The quartz is crystalline, and the sample sent gave at the rate of 25 grains per ton of gold.

"In the 8th section, at 720 feet, a small vein of similar size, and underlying, was cut, the sample of which only gave traces of gold. It is noticed that on cutting this vein a heavy flow of water was met.

"The rock where the tunnel had reached to from the west side, in June, was compact, granular, and of a dark grey colour, charged with pyrites, and only feebly calcareous.

"*On the Kennedy Bay side*—1*st Section* is a coarse granular, or sub-crystalline rock, light in colour, and containing pyrites, but weathering freely to a dark brown. On the west side of this band of rock are two quartz veins, 5 and 3 inches respectively, trending north-east, and underlying to the west at 20°.

"The samples of these sent gave at the rate of 28 grains per ton of gold.

"2*nd Section and* 3*rd Section.*—Very compact felstone, or indurated claystone full of pyrites in large masses and crystals.

"A glance at the suite of specimens submitted shows that, while there is considerable variety in the rocks cut through in the tunnel, after passing the 3rd section of 300 feet from the west end they all belong to the same group. The presence of carbonate of lime in large quantities, both as a constituent of the hardest and densest parts of the rock, and as secondary deposits in veins, is very interesting, and shows that, even if these rocks had at first a volcanic origin, as has been supposed, they have since undergone much alteration. The marked change at 300 feet, and the presence in the rock at section 3 of rolled fragments of the more interior rock, is sufficient proof of the existence of two formations belonging to different periods.

"All the rocks will be exhaustively analyzed and microscopically examined, so that the fullest benefit to science may be obtained from this most interesting work."

2. "On the Probability of a Water Supply being obtained for the City of Auckland from Mount Eden," by J. Goodall, C.E. (*Transactions*, p. 35.)

An animated discussion ensued.

3. "On the Prediction of Occultations of Stars by the Moon," by T. Heale, C.E. (*Transactions*, p. 57.)

Mr. T. B. Gillies was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with Clause 7 of the New Zealand Institute Act.

Seventh Meeting. 8*th December*, 1873.

New members.—Sir G. A. Arney, Chief Justice of New Zealand, T. Spencer, G. F. Edmonstone, A. Clark, J. E. Allen, J. Robertson.

The Secretary read the list of donations to the Library and Museum.

The Secretary stated that a complete set of rock specimens from the Tokatea Tunnel would eventually be placed in the Museum.

1. "On the Probability of a Water Supply being obtained for the City of Auckland from Mount Eden" (continued), by J. Goodall, C.E. (*Transactions*, p. 39.)

2. "Notes on the Proposition to supply Auckland with Water from Mount Eden," by J. Stewart, C.E. (*Transactions*, p. 40.)

This paper was read by the Secretary in the absence of the author.

A lengthy and animated discussion ensued, in which Mr. Baber, C.E., advocated Mr. Goodall's proposal, which was not received with favour by the majority of members who spoke on the subject.

3. "Notice of an Undescribed Species of *Cordyline* (*C. hookeri*)," by T. Kirk, F.L.S. (*Transactions*, p. 244.)

The paper was illustrated by specimens from the Herbarium of the Institute.

4. "Notes on Indigenous Materials for the Manufacture of Paper," by T. Kirk, F.L.S. (*Transactions*, p. 55.)

Recent specimens of most of the plants named were exhibited by the author.

Mr. Heale drew the attention of the members to the approaching removal of the Secretary to Wellington, and, after eulogizing his services to the Institute, proposed that the thanks of the members be presented to Mr. Kirk, with the expression of their cordial good wishes for his prosperity.

The proposition was seconded by the Rev. A. G. Purchas, supported by the President, and carried.

In expressing his sense of the honour conferred upon him, Mr. Kirk stated that, notwithstanding the trials through which the Institute had passed during the six years of its existence, it had never retrograded, but always maintained its position as the first, in point of number, of all the affiliated societies of the New Zealand Institute.

Annual General Meeting. 16*th February*, 1874.

T. B. Gillies, President, in the chair.

New members.—George Ranger, E. Hesketh.

The list of donations to the Library and Museum during the past month was read by the Secretary.

ABSTRACT REPORT OF THE COUNCIL.

The number of new members was greater than in any previous year. During the year seven meetings were held and seventeen papers read.

Numerous and valuable donations have been made to the Museum and Library, and specially by Mr. Kirk, F.L.S., of wood sections, New Zealand shells, a collection of British ferns, and other valuable additions.

The Council regret the very inadequate space at their disposal, and the

unsuitable buildings for the Museum and Library, and hope that means may be devised for providing the accommodation so urgently required.

They note the resignation of the Secretary, Mr. T. Kirk, F.L.S., and desire to record their appreciation of his services to the Institute during the last six years. But for his unwearied exertions and constant attention to the affairs of the society, it could not have attained its present amount of success. The Council feel that his removal will be a serious loss, not only to the Institute, but also to the Province.

The receipts for the year amounted to £333 6s. 3d., and the expenditure to £215 17s. 5d., leaving a balance of £117 8s. 10d., of which £10 3s. 10d. is carried to Building Fund and Investment Account. The entrance fees and subscriptions amounted to £232 1s., and the sum of £83 4s. 7d. had been spent in books and additions to the Museum.

Election of Officers for 1874.—*President*—Chief Justice Sir George A. Arney; *Council*—J. L. Campbell, M.D., J. C. Firth, T. B. Gillies, J. Goodall, C.E., D. Hay, Hon. Col. Haultain, Rev. J. Kinder, D.D., Rev. A. G. Purchas, M.R.C.S.E., J. Stewart, C.E., T. F. S. Tinne, T. Heale; *Auditor*—C. Tothill; *Secretary*—T. F. Cheeseman.

The President informed the members that steps were being taken to present Mr. Kirk, their late Secretary, with a substantial recognition of his services. Mr. Kirk had not been an ordinary Secretary. He had contributed largely, not only in papers, but also in specimens to the Museum and books to the Library.

The Rev. Dr. Purchas spoke in terms of praise of Mr. Kirk, and of the value of his services to the society as a scientific man of a high order and of a European reputation.

Considerable discussion took place on the urgent necessity existing for increased accommodation for the Library and Museum, and it was resolved that the Council be recommended to appoint a sub-committee especially to attend to the subject.

Resolved—That a vote of thanks be given to the President, Council, and Office-bearers of the society for their services during the past year, and that the same be recorded on the minutes of the Institute.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

FIRST MEETING. *5th March*, 1873.

Henry John Tancred, President, in the chair.

The President delivered the following opening

ADDRESS.

It is my duty, as occupying the honourable position of President of the Philosophical Institute of Canterbury, to which I have been elected for the current year, to inaugurate the present session by the delivery of an opening address. I can imagine that the rule which imposes upon me this duty might be turned to most useful account by one who had the capacity and knowledge required for making such an address instructive. Such an occasion as the present is one of the few which afford convenient opportunities for taking a general and comprehensive survey of the results which we have obtained, for giving a review of the progress made in the past, and for sketching out what may be achieved in the future; for furnishing, in short, an intelligent summary of the advance made towards the attainment of those objects for which this body was established—that is to say, the cultivation of science, literature, and art, and the development of the industrial resources of the Province. This, I think, was the ideal before the minds of those who framed our rules, when they made the opening address of the President a necessary preliminary to the commencement of our work for the year. It is, however, an ideal which can, in the nature of things, be very seldom realized. I need hardly say that I, at least, must abandon all hope of reaching, or indeed making an approach to it. None indeed can, in my opinion, adequately perform such a task but those who are conversant with all those departments of learning and culture which are comprised in the list of subjects just mentioned, and could set forth in detail the excellences, and criticise with justice and discrimination the views propounded on all those subjects which have been treated of before this, as well as before those other societies which have become incorporated with the New Zealand Institute. But while professing my inability even to approach the standard which I have indicated, I think it not unprofitable to keep that standard before us, as one to be aimed at, though by doing so I may be rendering my own shortcomings more marked by the contrast.

Without attempting to undertake such a review as the one suggested, I take the more humble and less pretentious course of recalling that which must be in the recollection of those whom I address, and content myself, in the first instance, with the mere recapitulation of the titles of the papers read before the society. A dry enumeration of these, as showing what questions have been discussed and the direction which our enquiries have taken, may be not altogether without its use, as it will furnish, in a compendious form, a list of the subjects which have lately been engaging our attention, quite apart from the consideration as to how far they have advanced the cause which we desire to promote. The following is a list of the papers which have been read during the last session:—1. "Darwin's Provisional Hypothesis of Pangenesis," by Dr. Barker; 2. "On the Size and Weight of the Smallest Particles Visible to the Highest Powers of the Microscope," by Dr. Powell; 3. "On Seven Species of Spiders of the Genus *Salticus*, probably New to Science," by Dr. Powell; 4. "On the Stridulating Organs of the Cicada," by Dr. Powell; 5. "Notes on New Zealand Birds," by Dr. Otto Finsch, of Bremen; 6. "On some Undescribed New Zealand Fishes," by Dr. Haast; 7. "On the Practical Uses of an Observatory," by W. M. Maskell; 8. "Remarks on the Coleoptera of Canterbury, New Zealand," by C. M. Wakefield; 9. "On *Phalacrocorax punctatus* (Spotted Shag)," by T. H. Potts; 10. "Notes on the Birds of New Zealand," by T. H. Potts; 11. "Apterygidæ," by T. H. Potts; 12. "On the Direct Injuries to Vegetation in New Zealand by various Insects, especially with reference to Larvæ of Moths and Beetles feeding upon the field crops, and the Expediency of Introducing Insectivorous Birds as a Remedy," by R. W. Fereday.

The mere enumeration of the papers contained in this list, if it does nothing else, must make us experience a feeling of satisfaction, not only at the intellectual activity which it discloses as existing amongst us, but also at the fact which it establishes that this society has been made the depository of the instruction and information thereby afforded. A large portion of these papers is devoted to the elucidation of questions which are more especially the province of a local society, such as this—to the discovery of those truths, and the unveiling of those mysteries which surround us here. It appears to me that this also is a subject of congratulation. Not, indeed, that I desire to see our attention directed exclusively to matters of local import, to the entire or even partial neglect of those larger truths, or of those universal principles which apply equally, whether on this side of the globe or on the other. Unless we fortify ourselves by the study of these—unless we avail ourselves of the accumulated learning of other countries, and of other times—we shall never rightly understand the objects which present themselves to us here. But, besides and beyond those general truths which apply everywhere, each country

has special problems to work out, special enquiries to prosecute, which can be nowhere prosecuted so effectually as on the spot itself. It must be clear to all that we here have a new order of problems to deal with, whether in science or literature, politics, or social economy. The questions arising out of them, and the difficulties surrounding them, confront us under new forms, and must be grappled with by new methods. The knowledge which has been accumulated in other countries is, after all, for the most part empirical in its nature. It is the result of trial and experiment under certain conditions. Alter the conditions or the surrounding circumstances, and the same cause would produce a different effect. So it is with us.

Here in New Zealand it is not only probable, but certain, that many of those conditions under which we live are different from those which obtain elsewhere, and thus those dicta, which are accepted as absolute and unquestioned truths in one country and under one set of conditions, may not be so in another country and under another set of conditions; consequently, even those discoveries which have been made, and that knowledge which has been acquired elsewhere, require to be tested and verified here before we can accept them absolutely as a basis and starting point of our investigations. In some cases the differences are broad and palpable; in others they are more subtle; in others, again, they may not as yet have been perceived at all. But this, at least, is indisputable, that where the cause is different the effect will, in most cases, be different also, and that therefore the laws which have been accepted elsewhere as immutable may be modified or altogether neutralized here. Take, as an illustration, the question as to how the earth of New Zealand acts on the electric current. This question was raised in a paper read before the Institute by Mr. Wright. Our conception of the laws which govern the relation of the earth to electricity has been rudely disturbed by the ideas therein suggested. The observations recorded by Mr. Wright would seem to lead to the conclusion that the earth here, instead of dispersing, is a bad conductor of electricity. He says that on the line to the north of Christchurch, many of the telegraph poles having fallen down, the wires were in contact with the ground, but that, notwithstanding this and contrary to his expectation, insulation was still preserved, and messages could be forwarded along the line from Christchurch to Wellington. So far as is known, the author says—and he supports this assertion by the testimony of persons versed in practical telegraphy—this would have been impossible in any other part of the world. It is true his conclusions are disputed by Mr. Duigan, in a paper read before the Philosophical Society at Wellington. I do not myself venture to express an opinion on the question. I will only say that to my mind Mr. Duigan's paper does not satisfactorily account for all the phenomena recorded by Mr. Wright. I am content to leave the question undecided. It is sufficient

for my present purpose to observe that there is nothing inconceivable or absurd in the supposition that the laws which regulate the action of electricity on the earth in other countries are here inoperative, or superseded by other laws, so as to produce a different result. But this is a question which, as a mere question of abstract science, requires further investigation; it is one also of very great practical importance. If it be indeed true that the conditions under which electricity exists here, that the influence which it exerts on the earth here is different from that which it exerts elsewhere—then some of the most important of our industrial occupations must be, to a greater or less extent, affected by the difference. That electricity is a most powerful agent in the material world is a well-established fact. No one doubts that it performs a distinguished part in the economy of our atmosphere, and there is every reason to suppose that its action is still more general—that it exercises an influence almost universal over the laws of organic matter as well as over the functions of organic life. Now, it is not unreasonable to suppose that, in a country where the earth, instead of dispersing, resists electricity, the existence of this anomaly would be felt in numberless ways, and necessitate numberless modifications of ordinary practice. As a matter of fact, from whatever cause this may arise, I think it is acknowledged, for instance, that many kinds of plants when grown here lose some of those properties which they possessed in England.

Animal life, again—in our sheep, our horses, our cattle, and our dogs—appears to undergo very considerable modifications. So it is with our social and political life. The most superficial observer can perceive that the questions with which we have to deal here are not identical, either in form or in substance, with those which agitate other communities. Thus it is that we have here special problems to solve, which none can solve so satisfactorily as ourselves. In the solution of these we must trust to our own efforts, and not lean upon foreign learning and foreign aid. We have greater facilities than others for performing the task allotted to us, because we have better opportunities for observation. We can examine into the object of enquiry on the spot, in its native locality; we have before our eyes all the circumstances by which it may be affected, and we have facilities, not enjoyed by others, for daily and hourly observation of any changes which may take place. Others at a distance can gain this knowledge only at second hand, and can have no certain means of testing and verifying the information so received. Any observations which may be made here, and any new truths which those observations may establish, become then no longer of local importance, but are new lights thrown upon the universal science of the world, because they indicate the circumstances more minutely upon which the results obtained depend. Our means and appliances for study in both these directions—the

local and general, the particular and universal—are constantly on the increase. Materials for these investigations are rapidly accumulating in our Museum. I regret that the valuable report lately presented by the trustees of that institution has not yet appeared in print. It would be seen from it that not only have we obtained valuable contributions from abroad, but that local efforts have not been wanting, by collectors in various parts of the Province, to furnish local specimens to the general store. This latter class of contributions has, to my mind, a special value over and above the value which the specimens may have in a scientific point of view. Not only do they serve to illustrate the natural history of this country, they also give evidence of a general feeling of interest among the public at large in the advancement of science.

In looking over the list of contributors I was much struck with the large number of children and young people who have sent contributions. Nothing can be more gratifying and more encouraging for the future of science here than this fact, because it shows that there are many who, at an early age, are beginning to acquire those habits of thought and observation which are the indispensable conditions of usefulness and distinction at a riper age. I hope that this single fact affords evidence that, if we cannot as yet boast of any great things achieved in the cause of science, we are at least laying a good foundation by first enlisting sympathy and co-operation. We shall, indeed, be rendering important services to science if we do nothing more than foster and encourage a spirit of enquiry and observation and love of study. This, I think, should be the special object of a society such as ours. It is the faculty which it possesses of promoting that object which, to my mind, gives to this society its distinctive value, and it is as engaged in this work that we can fairly, as a body, claim the title of a learned society. Learning and science must, it appears to me, in order to be effectually promoted, be placed upon a much broader basis than that which they have hitherto occupied. They must look for their advancement, not only to assistance from the learned, but from all who can appreciate the value of learning in others. It is only by enlisting the interest, the sympathy, and the co-operation of all that we can hope to flourish as a learned society. It is on these grounds that I consider myself, as well as those other members who do not pretend to any special attainment in any branch of learning, qualified to take part in the proceedings of this Philosophical Institute, all the members of which, whether learned or unlearned, may justly claim the title of philosophers in the original sense of the word; that is to say, lovers and admirers of wisdom and learning, though not necessarily themselves learned.

It may appear paradoxical, but I believe it to be strictly true, that one condition of our success as a learned society is, that this Institute does not consist exclusively of learned men. That sharp line of demarcation

between the learned and unlearned,—that "learned Brahminism," as it has been called, which shuts out the general public from all participation in scientific enquiries—has, no doubt, in former times had the effect of causing science to languish. This Institute, on the other hand, recognizes the opposite and the wiser principle, that in learning, as in everything else, there are gradations of excellence—that none are so high as to be able to dispense with all help, and none so low as not to be capable of giving some assistance; and that even those who can do nothing at all in the way of contributions to the general stock of knowledge can do much by encouraging and cheering on the others. It is not very long ago that an opinion prevailed that the more exclusive a learned society was—the more rigidly it discarded those who had not reached a high standard of excellence—the more profound would be the work done, and the more would the cause of science flourish. It was thought, and I am not sure that the opinion is altogether exploded, that learning was best advanced by being prosecuted, so to say, in a concentrated form—by confining it to a small knot of learned men, from which the general community was excluded. But the result of such an experiment among ourselves would be certain failure; for, although it is indispensable to the very existence of such a society as this, that it should contain among its members persons of learning and science, it is neither indispensable nor desirable that it should cut itself off from those who make no pretensions to these acquirements. The evils of isolation from outside sympathy receive, I think, an apt illustration in the condition of learning in different countries of Europe during the seventeenth century.

The contrast presented between those countries where learning was honoured and appreciated, and where there was a free interchange of ideas between the learned and the people at large, and those where learning was a thing apart from ordinary life, would, I think, be an interesting subject of study. During that period which I have mentioned, England, France, and Italy belonged to the former of these classes. Here the influence of learned men was diffused among the public. Their labours were, to some extent, understood and valued. In Germany, on the other hand, there was no such community of feeling. Learned men were a class altogether apart. The people, steeped in ignorance, or, at best, but very imperfectly educated, looked with distrust upon their learned men; while these, in their turn, regarded the people with contempt, and made no efforts at conciliation. There is a passage by the French academician, Duclos, which sets forth very well the great advantage to both classes—to the learned no less than the unlearned—arising out of the reciprocal action of the one upon the other. "In former times," he says, "the learned were secluded from the world. Buried in their studies, they only looked for honour from posterity while working for their contem-

poraries. Their honest, but uncouth, ways had nothing in common with the manners of society. Men of the world, at that time less educated than now, respected indeed their labours and, still more, their renown, though they considered themselves incapable of holding intercourse with them. Rather out of respect than from aversion the learned were kept at a distance. Gradually, however, the taste for art and science made itself felt, so that at last those who had no natural liking for them thought it necessary to affect it. Now the men of science began to be sought out, and the more they mixed with the world, so much the greater was the pleasure afforded by their society. On both sides there was something gained. The men of the world cultivated their minds ; they became refined, and enjoyed new pleasures. The men of science gained for themselves favour and respect. Their intellectual faculties were brought into play ; their manners became more gentle, and they gained an insight into many truths which they never would have got from books." Such is a description of the intellectual state of France and Italy and England during the seventeenth century.

In Germany, on the other hand, the case was altogether different. Bacon's philosophy had, indeed, not been altogether without effect here also ; but it had only taken possession of a few distinguished individuals, who either received no encouragement at all, or else were obliged to look for sympathy to foreign countries. The great Kepler, the discoverer of the laws of motion of the planetary bodies, died a beggar at Ratisbon, while soliciting from the Diet the arrears of his wretched pension. Otho, of Guericke, the inventor of the air-pump, and Hevelke, the discoverer of the libration of the moon, both pursued their studies in seclusion and at their own expense, carrying on a correspondence, not with their own countrymen, but with philosophers in England or France. Hevelke became a member of the Royal Society in England ; Louis XIV. gave him a pension, and it was a Frenchman who bought his writings. Learned societies, such as those which had been formed in London and Paris, were not so formed in Germany at that time. While such a state of things existed, one can understand the complaint of Leibnitz, that among all nations Germany alone was so unwise as not to recognize its learned men, and that, in the absence of that support from the people at large, the finest intellects of Germany would either be destroyed, or would seek an asylum with some other community more alive to the value of their services and to the advantage of their presence in its midst. Thus two evils affected the learned class ; on one hand it was held in no esteem by the public, and on the other it lost its own self-respect by being forced to exist in a state of servile dependence upon the caprice of the rich and powerful, either at home or abroad. While the learned of other nations could address their countrymen in their mother tongue, those of Germany found it useless to write in

German, owing to the general want of interest felt by the Germans in their studies, and so they adopted Latin as the medium of communication with those who could understand and appreciate them. Thus Germany was the last of the nations of Europe to foster native learning and talent. We all know how the Germans have since sprung forward to the front ranks in all kinds of mental culture; but for a long time they were retarded in their onward course by the indifference and want of sympathy among the people. Traces of the old leaven and of the idea thus engendered—that all refinement was only to be sought for in foreign countries—may still be perceived even in the latter part of this last century. Familiar instances will occur to every one; French teachers were retained in noble families for the instruction of their children; Frederick the Great wrote French with greater ease than German; all his works, I believe, and they are tolerably voluminous, were written in French. He surrounded himself with men of learning, not from Germany, but from France—Voltaire, Diderot, D'Alembert, Maupertius, and others. It was the fashion of the time—a fashion which had arisen, I believe, from a habit of disregarding the more humble efforts to contribute to the cause—that of relying on foreign aid, rather than of fostering and encouraging native talent and forming a native school of learning. What was the result? The barrier which was raised between the learned and the unlearned, instead of causing literature and science and art to flourish, caused them to decay and languish. I do not think that we have to fear any danger of this kind. We exclude none from our body who are anxious to join in promoting the cause in which we are engaged. But if we are free from the charge of exclusiveness in this particular, I am not sure, if I may be permitted to say so, that we are altogether secure from exclusiveness of another kind.

We have four classes of objects which we wish to cultivate: science, literature, art, and the development of the industrial resources of the Province. Now, it appears to me that of these four we have hitherto paid attention to only one, viz., science, by which is to be understood physical science—that is to say, as I understand it, the observation of natural objects. In a new country, no doubt, this is a study which ought to engage a very large portion of our attention, but, if we devote our efforts exclusively to this branch of learning, we shall be neglecting those studies which are of no mean value in developing the faculties, in disciplining the mind, in training the intellect, and refining the taste, and so aiding the prosecution of studies connected with the cause of science itself. We have, as yet, done nothing for the advancement of literature, nothing for the advancement of art, although we have within our reach, as a stimulus to its cultivation, that magnificent donation to the Museum by Mr. Gould; nor, lastly, have we as yet applied ourselves to the development of the industrial resources of the Province, notwithstanding the liberal

endowment made by the Provincial Council for the purposes of a school of technical science. It is, I know, from no fault of the Institute that all these subjects have been so neglected. The Institute itself does not, and cannot, prescribe the nature of the questions to be brought forward. It is, no doubt, difficult to say how this evil (for evil I hold it to be) is to be remedied, but I think it is one to which I may not improperly refer. It is, I think, a proposition which cannot be controverted, that if we confine our attention exclusively to one set of subjects, if we discard all which lies beyond a comparatively narrow horizon, we are in danger, not only of circumscribing our field of action and of usefulness, but of giving a one-sided character to our efforts in that narrow field itself; and so, ultimately, instead of being entitled to the comprehensive name of a philosophical body, we may sink into the narrower sphere of a scientific society.

My principal object in hazarding these remarks is to suggest to those members whose intellectual pursuits have been outside the field of physical science, that they also should bring some contributions in their respective subjects. It would, I think, be a mistake to allow the feeling to grow, which no doubt to some extent has taken root, that all subjects not directly connected with physical science are out of place here. It is well to remember that this Institute embraces a much wider circle than this, and that there are many of its members who would feel great enjoyment in listening to papers, and taking part in discussions, on subjects of a different nature. But minor defects of the kind alluded to, after all, sink into comparative insignificance when we remember the broad, patent fact that this Institute is becoming steadily more successful in its efforts, because more generally appreciated, year by year. This is the best test of our progress, and the result warrants me in expressing a confident hope that the Institute will, during the present session, maintain that high character which it has from the first enjoyed.

Dr. Haast said he was sure he expressed the opinion of the members of the Institute when he said that the address just delivered was a very excellent one. It showed that the Institute had acted wisely in electing Mr. Tancred to the position of President.

SECOND MEETING. *2nd April*, 1873.

H. J. Tancred, President, in the chair.

New member.—C. J. Foster, LL.D.

1. "On the Desirability of Dedicating to the People of New Zealand Small Areas of Ground, assimilating to the Village Greens of England," * by F. E. Wright.

* This paper appeared at length in the "Lyttelton Times" of a subsequent date.

(ABSTRACT.)

The author said he thought that if his suggestion was acted on it would have a beneficial influence on the character and stamina of the future inhabitants of the colony. The village greens of England constitute a common property, on which squire and ploughboy meet on equal terms. It had been his good fortune to witness scenes of mirth and joyfulness on four or five village greens, which had conveyed to his mind the most perfect ideal of unalloyed happiness he had ever seen. Children play there with an independence which can only arise from the intuitive feeling in their minds that if they do not own their playground no one else does. He firmly believed that the agricultural labourer's pleasantest recollections were of the hours of his youth spent on the village green of his natal place; and that, when emigrating, such reminiscences went far to enhance his love for the land of his birth. The author then remarked that the waste lands of the colony were being sold without any commons being left, so that games of cricket, etc., are commonly advertized to be played in paddocks kindly lent for the purpose. Soon, in this Britain of the South, when villages are populous, there will be no playground for children but the long, straight, and dusty roads; and the love of country, which would have been engendered by playing on a common, will find no place in their hearts. There should be no walks or flower beds, as in city parks; no right to graze cattle; the green should be left in a state of nature, except that the village club might level a place for their games. Medical men could, doubtless, point out that reserves are necessary on sanitary grounds; that the free use of the muscles, and the joyous abandon of youthful games are conducive to the development of a perfect body and a virtuous mind. He would not venture to trench on the legal part of the question.

2. "Note on the Occurrence of *Dermestes lardarius* and *Phoracantha recurva* in Canterbury, New Zealand," by C. M. Wakefield. (*Transactions*, p. 153.)

THIRD MEETING. *7th May*, 1873.

G. W. Hall in the chair.

On the motion of Dr. Turnbull, seconded by Dr. Powell, resolved—That a Standing Committee be appointed to watch over the formation of townships, whether Government or private, so that a piece of land be set aside in each for the purposes of recreation, etc. The Committee in each case to bring the subject before the Government, so that a recreation ground, in proportion to size of township, may be set aside. The Standing Committee to consist of Dr. Coward, Mr. Bray, Mr. Wright, and Mr. Fereday.

FOURTH MEETING. *4th June*, 1873.

Julius Haast, Ph.D., F.R.S., in the chair.

1. "*Résumé* of the Characters of the Family Epeiridæ," with illustrations, by Ll. Powell, M.D.

2. "Notes upon certain recently-described New Genera and Species of *Coleoptera*, from Canterbury, New Zealand," by C. M. Wakefield. (*Transactions*, p. 155.)

FIFTH MEETING. *2nd July*, 1873.

H. J. Tancred, President, in the chair.

New members.—J. Townsend, G. A. Reade, A. Ormsby.

1. "Observations on the Occurrence of a Butterfly, new to New Zealand, of the Genus *Danais*," by R. W. Fereday, C.M.E.S.L. (*Transactions*, p. 183.)

2. Dr. Turnbull read extracts from the Report of the Royal Commission of Victoria on Diptheria, and made observations on the same.

SIXTH MEETING. *6th August*, 1873.

H. J. Tancred, President, in the chair.

1. "On the Occurrence of a New Species of *Euphysetes* (*E. pottsii*), a remarkably small Catodont Whale, on the Coast of New Zealand," by Julius Haast, Ph.D., F.R.S. (*Transactions*, p. 97.)

2. "Note upon recently-described New Zealand *Coleoptera*," by C. M. Wakefield.

Dr. Haast expressed his concurrence with the author's opinion that all new descriptions of New Zealand species, published in Europe, should be re-printed in the colony.

SEVENTH MEETING. *3rd September*, 1873.

J. Inglis in the chair.

New member.—D. S. Montague.

1. "On *Harpagornis*, an Extinct Genus of Gigantic Raptorial Birds of New Zealand" (Part I., containing Descriptions of the Pelvis of *H. moorei* and *H. assimilis*), by Julius Haast, Ph.D., F.R.S., Director of the Canterbury Museum. (*Transactions*, p. 62.)

Eighth Meeting. 1*st October*, 1873.

H. J. Tancred, President, in the chair.

1. "On *Harpagornis*, an Extinct Genus of Gigantic Raptorial Birds of New Zealand" (Part II., containing Descriptions of the Leg and Wing Bones), by Julius Haast, Ph.D., F.R.S. (*Transactions*, p. 62.)

2. "Further Notes on recently-described New Zealand *Coleoptera*," by C. M. Wakefield.

Annual General Meeting. 5*th November*, 1873.

John Inglis in the chair.

ABSTRACT REPORT OF THE COUNCIL.

The Council regret they cannot congratulate the members on the progress made during the past year, for, though the number of members is not materially less, the papers read have been few, and the attendance small. They hope that during the year it may attain to such a position as it should occupy among the scientific societies of New Zealand.

The number of members is 77. Nine meetings have been held, at which fourteen communications were read, and the average attendance at meetings has been ten.

The Council desire to record their profound sense of the loss which the Institute has suffered through the death of Dr. A. C. Barker.

Mr. W. M. Maskell, assisted by other members, has undertaken to write the History of Canterbury, in accordance with a former resolution.

In July last a valuable "Catalogue of New Zealand Neuroptera" was published by R. M'Lachlan, F.L.S., in the "Annals and Magazine of Natural History," with the express intention of assisting the entomologists of this country; and the Council take this opportunity of expressing their grateful appreciation of Mr. M'Lachlan's disinterested services in the cause of science, and also of making known their opinion that this Catalogue should be re-printed in the next volume of the "Transactions."

A microscope has been obtained, and the sum of £10 has been voted for the purchase of slides. The same sum will also be spent on works of natural history.

The Council make an appeal to educated and professional men to join the society.

The Treasurer's report shows the receipts during the year to have been £164 2s. 6d., the expenditure having been £140 12s., leaving a balance of £23 10s. 6d.

Election of Officers for 1874.—*President*—Julius Haast, Ph.D., F.R.S.; *Vice-Presidents*—Ll. Powell, M.D., G. W. Hall; *Council*—His Honour Mr. Justice Gresson, W. Montgomery, R. W. Fereday, Dr. J. S. Coward, H. J. Tancred, Rev. J. W. Stack; *Hon. Treasurer*—J. Inglis; *Auditors*—J. Palmer, R. Wilkin; *Hon. Secretary*—C. M. Wakefield.

His Honour W. Rolleston, B.A., was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with Clause 7 of the New Zealand Institute Act.

Extra Meeting. *4th December*, 1873.

Julius Haast, Ph.D., F.R.S., President, in the chair.

1. "On the Birds of New Zealand" (Part IV.), by T. H. Potts, F.L.S. (*Transactions*, p. 139.)

2. "On *Cheimarrichthys fosteri*, a New Genus belonging to the New Zealand Fresh-water Fishes," by Julius Haast, Ph.D., F.R.S., Director of the Canterbury Museum. (*Transactions*, p. 103.)

3. "Notes on the Ornithology of New Zealand," by Walter L. Buller, D.Sc., F.L.S. (*Transactions*, p. 112.)

4. "List of the Lepidoptera recorded as having been found in New Zealand previous to the Year 1871," by R. W. Fereday, Corresponding Member Ent. Soc. Lond. (*Transactions*, p. 171.)

Dr. Haast exhibited a skeleton of *Aptornis.*

First Meeting. *5th March*, 1874.

Julius Haast, Ph.D., F.R.S., President, in the chair.

New members.—Hon. E. W. Stafford, Hon. J. Barton A. Acland, Rev. W. J. Habens, John Anderson junr., C. C. Corfe.

The President delivered the following

ADDRESS.

When two years ago you kindly assented to my request to elect some other member of our society as your President, I thought that you would continue to do so at least for several years more, hoping that under those circumstances we should have been privileged to listen to a series of addresses for the opening of each session, in which the president elect would have given us, either the result of his own individual studies, or the experience obtained during the performance of his professional duties. However, whatever may

have been my individual wishes, I have bowed to the flattering and unanimous opinion of the members of this society, and have again ascended the presidential chair, trusting that you will kindly overlook my shortcomings. Once more I beg to thank you for this proof of your confidence, and I wish at the same time to assure you that, as in the past, so in the future, it will be my earnest endeavour to advance the interests of our society, which, I trust, will rise in a very few years to a conspicuous place amongst its sister institutions in New Zealand. Generally it is the custom of the president elect of a scientific body to devote his opening address either to a general survey of the scientific work done during the year, to allude to important discoveries in the several branches of science, or to select one or several special subjects, of which, by his own vocation, he is able to trace the advancement in years past.

Owing to the peculiar geographical outlines with which New Zealand is endowed, we do not possess one intellectual centre, as is the case in most older countries, or even in many of the neighbouring colonies; but the favourable position and high aspirations of most of the provincial capitals, aided by the foresight and wise legislation of the Provincial Councils, have secured to them peculiar advantages, which generally are not neglected, and will, I have no doubt, be greatly instrumental in securing the rapid intellectual and material development of this colony in every direction. Under these circumstances the President of this Institute, as well as those of the other societies forming part of the New Zealand Institute, have followed a middle course, and, by devoting some portion of their addresses to general observations, have not neglected to enter into those special topics with which, by original research, they are best acquainted. And whilst the New Zealand Institute has done good work in acting as the publishing medium of these societies, I think, in the interest of the colony and of members of the affiliated societies, that a further step should be taken to make this central institution still more useful.

Amongst the improvements which I might venture to suggest, it would simplify matters very much if the Presidents of the five affiliated societies, or as many more as join in the future, were Governors *ex officio*, by which the Board of Governors would gain in strength, and give each society, as it were, a personal interest in the doings of the Central Board, always provided that their attendance and assistance are required, and that their office is not an honorary sinecure. At the same time it would be desirable to have a general meeting of all the Governors each year at one of the centres of population, giving precedence to those where affiliated societies are located. During these meetings, which might be arranged in the manner of those of the British Association for the Advancement of Science and other similar institutions on the Continent, the principal work of the year could be done, and thus all the chief towns in the colony would in their turn derive the advantages of such

meetings. Acquaintances would be formed to mutual advantage, and local rivalries led, at least in intellectual matters, into such channels that they would benefit the country at large. And thus the high position which the New Zealand Institute has already obtained amongst kindred societies would not only be maintained, but the advantages derivable from it would become more manifest in each part of the colony where the meetings of its members were held.

Proceeding to the few topics I have chosen for to-night, I wish to make first a few observations on the Geology of the Canterbury plains, as far as their mode of formation is concerned. I thought that this subject, to which I have devoted considerable time, and of which my reports on the formation of the Canterbury plains, 1864, and on the head waters of the River Rakaia, 1867, give the necessary *data*, did not require any more consideration, except adding those new details which further surveys and altitude observations, or railway cuttings, etc., would bring within our reach. However, as Captain Hutton (in a paper "On the Date of the Last Great Glacier Period in New Zealand," published in the Transactions of the New Zealand Institute, Vol. V., pp. 384–393) has come to the conclusion that the Canterbury plains are of marine formation—although when writing that paper he had never seen them, and moreover finds, in a most peculiar way, in my own reports a portion of the proofs for his assertion—I am obliged to return to this subject to put the reader of that article on his guard; the more so, as Captain Hutton, since the article alluded to has been written, has paid a flying visit to the Malvern Hills, examining at the same time the middle course of the Rakaia and Waimakariri rivers, and, as he since informed me verbally, has not changed his mind in respect to this geological question.

Fortunately, since my reports were written the extensive surveys of Mr. Doyne and other gentlemen, made for railway and other purposes, have confirmed in a remarkable degree my views concerning the "fan" character of the deposits of the principal rivers in every respect. I wish to refer here only to the interesting and highly-instructive map attached to Mr. Doyne's second report upon the River Waimakariri and the lower plains, where the fan levels are shown over a large area of ground. Instead of refuting all Captain Hutton's principal arguments, or showing how that gentleman has not read my reports with such care as he should have done if he intended to quote therefrom, I may be allowed to present you, as concisely as possible, with a short *résumé* of the points at issue.

I stated and proved, as I trust somewhat satisfactorily, that in post-pliocene times—without, however, being obliged to assume greater elevation of the land, which may or may not have existed—glaciers of enormous size were formed, which reached far down the present river valleys, in some instances even

advancing beyond the eastern boundaries of the ranges now bordering the Canterbury plains proper. Of these gigantic ice streams, the glacier advancing through the then united valleys of the Southern Ashburton and Northern Hinds was, if not the largest, at least equal in size to the Rakaia glacier, owing to the fact that it received enormous additions from the valley of the Rakaia (by the lake Heron) and from that of the Rangitata (by the lakes Tripp and Acland depressions).* It will thus at once become manifest that Captain Hutton's argument (p. 387) concerning the small size of the present Ashburton and Hinds rivers falls to the ground, and that he was not sufficiently acquainted with all the facts given in that report of mine.

We thus have north of Timaru four distinct fans, namely, those of the Waimakariri, Rakaia, Ashburton, and Rangitata, with smaller rivers having their sources in the front ranges running between them; the Selwyn between the Waimakariri and Rakaia fans, the Northern Ashburton between those of the Rakaia and of the Ashburton—Northern Hinds; and the Southern Hinds between the latter and the Rangitata fans. The gravel formation of these fans, where they remained undisturbed, does not warp, as Captain Hutton assumes, round the spurs of the hills at the same level that it has at the river gorges, but has a steady fall towards the small streams flowing between the fans of the two large glacier torrents; however, in some instances, this has been concealed by detritus from the mountains, or by re-arrangement of the original river beds on the surface of the upper portion of the plains when the glaciers retreated. But, I may add, the general outlines are nevertheless clear and distinct.

In my geological notes on the Malvern Hills† I have given an illustration of this. I have shown how the great Rakaia glacier, having also an outlet by the upper course of the river Selwyn, covered with its gravel deposits the lower eminences forming the Malvern Hills, west of the dolerite range, and had its outlet in a N.E. direction in the neighbourhood of Little Racecourse Hill, thus throwing, doubtless, the bed of the Waimakariri more to the north. When this glacier outlet ceased to flow and to deposit any more boulders and gravel in the district alluded to, the Waimakariri soon began to remove the alluvial beds thus formed by the Rakaia branch, until harder rocks upon which they were reposing were reached. This fact alone, I trust, will prove that a detailed examination of all physical features in that portion of the country is requisite to enable us to understand the sometimes complicated nature of the fluviatile beds, and that my explanation of the formation of the Canterbury plains is not a mere hypothesis, but based upon a great number of observations made during a number of years.

* See "Report on the Formation of the Canterbury Plains," by Dr. Haast, p. 9, *et seq.*

† Rep. Geol. Expl., 1871-72, pp. 33—36.

Captain Hutton, in the same paper, observes:—"It is so universally acknowledged amongst geologists that river terraces prove elevation, that it is quite unnecessary to go over again such well-trodden ground," and he brings forward a formidable array of scientific authorities in support. However, nobody ever doubted his statement, but he forgets that there is still another and important agency by which terraces are formed, and which, not only in New Zealand, but in many other mountainous regions, has been the principal, if not sole, cause of their formation—namely, the retreat of the river sources to higher and more distant regions. In my different reports, already cited, I have treated of that subject at length, and shown why and how rivers with less velocity do gradually lower their beds, so that I need not repeat myself here.

But a still more formidable objection to Captain Hutton's hypothesis presents itself: if the Canterbury plains were of marine origin, the beds of which they are composed would have preserved some traces of it; but, although we have clear sections several hundred feet high in almost every river, their fluviatile character is unmistakable. The boulders, shingle, gravel, sand, and ooze are all deposited as a river torrent would place them, according to their form and size, and according to the greater or less amount of water being brought down. The peculiar character of surf shingle is nowhere exhibited, but all the pieces of stone have the subangular form so peculiar to river shingle. Marine fossils are missing throughout. Moreover, if elevation had taken place during the post-pliocene or glacier period, Banks Peninsula would certainly show this most conspicuously; but what does a close examination of that interesting, isolated, volcanic region reveal to us? We observe no trace of marine action, except the results of a slight oscillation of about 20 feet, by which the peninsula has been raised after undergoing probably a similar submergence. It is true that its lower portion in several localities, up to 800 feet, is covered more or less with silt—a fine loam—which in many instances is a true slope deposit, partly derived from the decomposition of the rocks *in sitû*, or partly brought down from higher regions by running water. Moa bones and pieces of small land shells have been found in these deposits, of which there are many splendid sections to be examined, but nowhere could the least sign of marine life be detected in them.

This fact alone shows that the emergence theory has not the least foundation; on the contrary, from the nature of these silt beds and their partial denudation, we might conclude that the peninsula has undergone a depression since they were deposited. Had a rise of the ground taken place, by which the Canterbury plains had emerged from the sea, we certainly should find the proofs of it along the slopes of the peninsula in the form of raised beaches, deposits of sea shingle and sand with recent marine shells, but nowhere is a trace of such

easily recognizable beds to be found; and thus, even assuming that the clear and undeniable *data*, which the Canterbury plains present as to their origin, were not in existence, the character of the silt deposits on the slopes of Banks Peninsula, and the absence of recent marine beds, would at once compel us to reject Captain Hutton's new theory as incorrect in all its issues. Captain Hutton's attempts to prove the correctness of his own views by selecting a few unconnected passages from my own reports, which show, as I believe clearly, the subaerial formation of the Canterbury plains, are rather ingenious; but where he has done so he has either failed to follow the drift of my reasonings, or he totally misunderstood the explanations I gave of the observed facts.

And with these few remarks I wish to leave the subject, but not without expressing a wish that those who intend to learn something more of the matter should examine for themselves the points at issue, as accurate observations can be made, as it were, close to our own doors. Moreover, it is not my intention to refute in detail any theories which are unsupported by facts, as I should have to repeat what I have written before on the subject; and, in future, I shall only reply with the words, "go and see," used by Desmarest, one of the fathers of geology, when, towards the end of last century, the Neptunists wanted to draw him into an argument about the nature of basalt.

I have hitherto refrained from publishing any of my notes on the researches made during a number of years upon the accumulated treasures obtained in the turbary deposits of Glenmark, except a list of measurements of leg bones of different species, in the first volume of our "Transactions," and the description of the bones of the remarkable genus *Harpagornis*, in Vol. IV., always expecting that Professor Owen, whose truly classical labours have laid the foundations of the edifice of which present and future researches will only form additions, would himself review the whole subject at length. Finding, however, that instead of doing so, that illustrious comparative anatomist is inclined to unite, as it were, all the principal species with a struthious character into one genus under the general term of *Dinornis*, dropping altogether the name *Palapteryx*, I feel that I should not do my duty if I were to hold back the following notes any longer.

If it were our good fortune that Professor Owen could have access to the rich material which is exhibited in the Canterbury Museum, I am sure he would never have united under one genus a number of species which show such a remarkable diversity of character; but, as his description of single bones of some species, or at most of portions only of others, were given during a considerable space of time, ranging over more than thirty years, I can easily understand that Professor Owen will find every day, as the material increases, greater difficulty in making himself acquainted with all the details, unless he could have such a complete series as we possess in the Canterbury Museum to

refer to. Such a series would have afforded him at a glance a confirmation that the new arrangement which I venture to propose in the following notes is not based altogether upon unsound principles.

I am well aware that there are still many naturalists who think that the division of the bones of our extinct avifauna into so many species is a mistake, and that future researches will prove that what appeared to Professor Owen as several well-defined species were after all only various stages of age and growth of one and the same kind. However, in this respect the collections of the Canterbury Museum bear a strong confirmation of the correctness of the great English anatomist's conclusions. We possess, not only young bones of each species, from the chick to the full-grown bird, where—to take only one bone as a guide—the tarsal epiphysis of the metatarsus is not yet quite anchylosed,* but we have of each species a series of specimens of generally two distinct sizes, from which we may conclude that they represent the male and female bird of each species. In some instances, of which I shall speak more fully in the sequel, we possess of each species four distinct sizes, which might represent the two sexes of two distinct but closely allied species.

Although Professor Owen thinks that the back toe (*hallux*) was only a small functionless appendage to the foot, and that thus the existence or non-existence of such bone is of no consequence, and has, therefore, felt obliged to abandon this ground of generic distinction, I am more convinced than ever that it is of great importance, and that the principal division of our extinct struthious birds has to be based upon this, as I believe, constant character.† If we add to this all the other distinctive features, which I shall enumerate in the sequel, such as the existence or non-existence of a bony scapulo-coracoid, the shape of the sternum and of the bill, and many others, the presence or absence of a *hallux* becomes of still more importance.

* We possess, amongst others, the leg bones of a specimen of *Dinornis maximus*, which is in size only second to the largest bones we have, but in which this immature character in the metatarsus is not yet quite effaced.

† I formerly believed that an impression observed on the back of one of the first metatarsals of *Dinornis ingens* I ever obtained was there for the articulation of the back trochlea, but since then several more specimens of that species have passed through my hands, which showed that impression either only faintly or not at all. Dr. Jaeger, of Vienna, articulated a small back trochlea with the skeleton of *Dinornis ingens* found in the Moa Cave of Nelson, but there is no evidence that the small bone in question belonged to it. In my first paper of measurements, on page 85 of the first volume of the Transactions of the New Zealand Institute, I have already pointed to the distinct rough groove which *invariably* exists at the back of the metatarsus of a number of species, which I have now ventured to unite under the term Palapterygidæ. I may add that a number of back trochleæ in the possession of the Canterbury Museum, as to form and size, agree in a remarkable degree with the form and size of the bones of the different species belonging to that family. It would be strange if this striking coincidence, together with the rough grooves previously alluded to, should have misled me to draw wrong conclusions therefrom.

And I might add here another important peculiarity in these two main divisions, which was first pointed out to me by Mr. Fuller, and which is of great practical value when examining even the smallest bones. Mr. Fuller has found that in the mere handling of the bones a great difference is at once to be detected amongst those coming from the very same spot. Thus the remains of *Palapteryx* are harder, and have resisted more effectually the influence of time than those of *Dinornis;* the exterior dense crust is far stronger and thicker and is less smooth than in the latter. Moreover, the bones of the Palapterygidæ are not quite so porous as those of the Dinornithidæ, and consequently are heavier in proportion.

After these few introductory observations I now proceed to lay before you the scheme after which I propose grouping together the different species of our extinct struthious birds, giving, at the same time, some of the principal distinctive features of each group :—

A. Family DINORNITHIDÆ.

a. Genus *Dinornis.*

Metatarsus long, no hallux, pelvis narrow, sternum longer than broad, convex, with constant and well-marked coracoid depressions for the scapulo-coracoid bone; narrow and straight anterior crest, costal processes slightly developed, lateral processes standing at less angle than in the Palapterygidæ. Existence of a bony scapulo-coracoid; beak narrow and pointed, three inter-costals; skeleton altogether of a more slender stature than any of the Palapterygidæ.

1. *Dinornis maximus.*
2. *Dinornis robustus.*
3. *Dinornis ingens.*
4. *Dinornis struthioides.*
5. *Dinornis gracilis.*

b. Genus *Meionornis.**

Metatarsus long, no hallux, pelvis narrow like *Dinornis,* and the whole skeleton altogether more slender than any of the Palapterygidæ. Sternum convex, longer than broad, with a broad and well-curved anterior border; costal processes well developed, no coracoid depressions; bony scapulo-coracoid absent, beak well pointed and even narrower than in *Dinornis.*

1. *Meionornis casuarinus.*
2. *Meionornis didiformis.*

B. Family PALAPTERYGIDÆ.

a. Genus *Palapteryx.*

Metatarsus very short and broad, with hallux and hind toe; distal trochleæ

* From *meion,* less; and *ornis,* bird.

remarkably broad and divergent, tibia with both extremities largely developed and standing inward, so as to give the skeleton a bow-legged appearance; pelvis very broad and like the bones of the leg, and the rest of a truly pachydermal character; bill very obtuse and rounded at the tip; sternum flattened, broader than long, with a strong costal process, lateral processes standing at a higher angle than in any of the Dinornithidæ; no coracoid depressions in aged specimens; no bony scapulo-coracoid, two intercostals only.

1. *Palapteryx elephantopus.*
2. *Palapteryx crassus.*

b. Genus *Euryapteryx.**

Metatarsus short and broad, but not so pachydermal as the former, with a hallux and hind toe; tibia straighter, and without the extremities so enlarged as in *Palapteryx;* sternum longer than broad, more concave than the former genus, without coracoid depressions, but with strong and long costal processes, mesial portion anl process comparatively longer than in all the former subdivisions, no bony scapulo-coracoid, beak not so obtuse as in the former.

1. *Euryapteryx gravis.*
2. *Euryapteryx rheides.*

In the preceding list I have only entered those well-defined species of which we possess ample material for comparison and generalization, leaving several others, of which we obtained only portions, for a future notice; but amongst them I may at least allude to one species which appears to approach the Emu of Australia in its general characteristics. I had also the intention to add some notes on the crania of the different genera, but fear that it would make this address too long were I to give them here.

However, before proceeding there is one point to which I wish to draw your attention, namely, to the existence or absence of a bony scapulo-coracoid.

In the genus *Dinornis* we find deep and well-defined coracoid depressions in the anterior border of the sternum of each species; and the excavations have furnished us with a series of scapulo-coracoids which fit exactly into those depressions. Moreover, these small and peculiar bones, by their form and size, agree also in other respects well with the different species enumerated. However, when we examine the sternums of the genus *Palapteryx*, and principally that of *Palapteryx elephantopus*, we find some with well-marked depressions, others with only faint ones; whilst there are others, belonging apparently to aged birds, where there is not the least appearance of them.

Again, we possess a few sternums in which a depression exists on the one side, whilst it is missing on the other; so that we are compelled to conclude that no bony scapulo-coracoid could articulate with them. Moreover,

* From *eurys*, broad; and *apteryx*, without wings.

we have never found any scapulo-coracoids of a different form from those articulating with the five species of *Dinornis*, and, as we have obtained a number of the most minute bones of the smallest species, it would be difficult to conceive that a bone of such considerable size should altogether have escaped, the more so as so many specimens of *Palapteryx* were excavated. And, although this is only negative evidence, it is so strong that there is not the least doubt in my mind of the non-existence of a bony scapulo-coracoid. The same might, indeed, have existed in a cartilaginous form, attached to the sternum by cartilage, but of this we have no evidence. I am well aware that on physiological grounds the presence of that bone seems to be indispensable for the mechanism of respiration in birds, as Professor Owen has shown from his dissection of *Apteryx*, and he has lately again called my attention to the fact (letter to me, dated British Museum, August 5, 1873); but, with the *data* at present before us, I cannot alter my views, the more so as I do not deny that such a process might have existed as cartilage.

It will be seen from the subdivisions given above that I have not used the term *Dinornis giganteus*, as there seems to be a specific difference between the species of that name from the northern island, to which that term was first given by Professor Owen, and the largest bird of this island. In this I have followed Professor Owen, who has proposed the specific term of *Dinornis maximus* for the latter, which appears to have been altogether of more gigantic proportions than the North Island bird. I was once under the impression that a specific difference could be traced between the largest skeletons known, for which the above term *maximus* was first used by Professor Owen, and the somewhat smaller skeletons, for which for some time the designation *giganteus* was retained by me; but, after a careful examination of a number of skeletons, there remains not the least doubt in my mind that they all belong to the same species, with a gradual decrease of size and robustness. And even assuming that the largest skeletons belonged to the female birds—a similar considerable difference in size being also constant with the different species of *Apteryx*—there are so many intermediate forms that even the supposed line of division between both sexes is exceedingly difficult to draw.

Moreover, and this is peculiar to *Dinornis maximus*, there are scarcely two skeletons entirely alike; there are some which have a remarkably long metatarsus, whilst the other leg bones do not (at least at the same rate) increase in size; others are much stouter for their height. Altogether we might trace the same peculiarity in size and form as in a series of human skeletons selected at random.

The same is the case with the skeletons of the immature birds of this species, of which we possess portions from the chick to the full-grown giant bird, where the tarsal epiphysis is not yet so closely united with the metatarsus

but that the line of junction is still visible, where also a similar variety of form can be traced.

The difference in size between *Dinornis maximus* and *Dinornis robustus*, the next in size, is very marked and constant. Of the latter we obtained a series of two sizes, of which the largest might be assigned to the female.

Between *Dinornis robustus*, *ingens*, *gracilis*, and *struthioides*, besides their well-defined specific characters, there are also distinct breaks; each species possessing at the same time two constant sizes.

Of *Meionornis casuarinus* a series of four clearly-defined sizes are in our possession, so that we might conclude that we have two closely-allied species before us, of which the two largest sizes represent male and female of the one, and the two smaller male and female of the other. A considerable difference in size occurs between the smallest species of *Meionornis casuarinus* and the largest species of *M. didiformis*. In the latter we can distinguish also four sizes with a gradation similar to that observed in the former, so that I am led to believe that this species, like *M. casuarinus*, consists of two sub-species.

If we compare two skeletons of *Apteryx australis*, male and female, and two of *Apteryx oweni*, male and female, with each other, a similar distinct gradation is observable.

Palapteryx elephantopus has also four well-distinguishable subdivisions, of which the largest size is the most conspicuous and best marked, so that the suggestion ventured concerning two sub-species belonging to *Meionornis casuarinus* and *didiformis* applies equally to this remarkable extinct bird.

The division between this and the next species *Palapteryx crassus* is well marked, consisting, moreover, of two constantly-maintained sizes.

Euryapteryx gravis and *rheides*, which can easily be distinguished at a glance from each other, not only by their size but by their anatomical characteristics, consist each of two sizes only, to be attributed, as I suppose, likewise to difference of sex.

Amongst other species of extinct birds, of which the Glenmark turbary deposits have yielded remains, there is, first, the huge diurnal bird of prey which I described under the specific term of *Harpagornis moorei*. Another remarkable species is a ralline form of gigantic size, *Aptornis*, of which we obtained sufficient material for articulation, and which is closely allied to *Ocydromus*, the woodhen.

The remains of *Cnemiornis*, a gigantic goose, as first pointed out by Dr. Hector, have hitherto been very scarce, so that we possess only a few bones of it. It is remarkable that the excavations undertaken during a number of years did not yield a single bone of *Notornis*, which, therefore, either did not inhabit this part of the country, or was of extremely rare occurrence.

Of other species we obtained bones of *Apteryx*, *Stringops*, *Ocydromus*,

Himantopus, *Botaurus*, *Hæmatopus*, several species of ducks, and of a number of still smaller birds which cannot be distinguished from bones belonging to recent species. The remarkable fringed lizard, *Hatteria punctata*, was also an inhabitant of this island, as several bones belonging to it were found with the Moa bones.

Professor Owen having described at some length, in several of his memoirs on *Dinornis*, the affinities our struthious birds bear to those of other countries, pointing out at the same time the peculiarities in which they vary from them, it would have been unnecessary for me to add anything to the subject had not an attempt been lately made by Professor Alphonse Milne-Edwards, in Paris, to show, from a comparison of the remains of the extinct ornithic fauna exhumed in Madagascar, Mauritius, and Rodriguez, that in some distant ages New Zealand formed a portion of a large continent, or of a group of more or less extensive islands in the Southern Hemisphere, which at one time were in some way connected with each other. He thinks that additional confirmation can be obtained from the ascertained occurrence of different Ocydromidæ, such as the *Aphanapteryx* and the *Miserythrus leguati*, which latter he informs me (letter to me, dated "Jardin des Plantes, Paris, Aug. 3, 1873") bears close resemblance to our common woodhen (*Ocydromus australis*).

However enticing the tracing of close affinities must be to the naturalist-philosopher, I believe that it would be rather rash to conclude the connection of two such distant insular groups from a few forms of birds only. Leaving the general question alone for the present, to which I shall return shortly, it is impossible for me to conceive that two countries, which in all other respects have such a dissimilar and distinctive flora and fauna, could have been united in any way without having left other living proofs of such connection in their present endemic organic life, not to speak of fossil remains.

We know that Madagascar is a zoological sub-province of South Africa (Ethiopian region), but having a fauna so peculiar that it must, according to Sir Charles Lyell, have been separated from Africa probably since the upper miocene era. New Zealand, on the other hand, although it may have been formerly of larger extent, has never been more than an oceanic continental island from a zoological point of view, a theory first propounded by Darwin and Wallace, and with which I fully agree. It would be rather a difficult task to prove, upon such slender grounds as the presence of a few species of Struthious and Ralline birds will afford, that both countries could possibly have been connected. Moreover, the difference in the anatomical structure of the three Madagascar species of *Æpyornis* and of the New Zealand Dinornithidæ—using this latter term in a general sense—is so enormous that I fail to see how they possibly could prove that connection in any way.

I cannot agree with Professor Alphonse Milne-Edwards, that the *Æpyornis* stands nearer to *Dinornis* than to the Ostriches, Cassowaries, and Emus, except that the fossil bones of Madagascar and New Zealand have a more pachydermal type than the recent species named. But I may point out that the fossil *Dromornis australis* of Australia shows similar characteristics, and I am sure if fossil remains of struthious birds in beds of post-pliocene age were discovered in Africa, America, and Asia, that they would exhibit a similar pachydermal character.

Judging from Professor Milne-Edwards' own excellent memoirs on *Æpyornis*, and the fine casts of the unique fossil bones in the Paris Museum, which he was good enough to send to the Canterbury Museum, I am unable to trace their relationship with our Dinornithidæ. It appears to me that the Madagascar species are separated from the former by many fundamental differences, such as (to point out only a few) the pneumatic foramen in the femur and the straightness of the trochleæ of the metatarsus. And, although I am convinced that the struthious character of *Æpyornis* has sufficiently been proved by the eminent Paris comparative anatomist, I can easily understand that there was at first some show of reason for placing it amongst the sarcoramphous vultures, as has been done by Professor Bianconi.

However, speaking of the principle itself, I wish to point out that if we were to decide, from a few isolated species in two distant countries which show some or even a close resemblance to each other, that these countries must have once been connected in some way, we should in many instances form erroneous conclusions. We might as well say that, because there are struthious birds in Australia, the Malay Archipelago, Africa, America, and Asia, all these countries must have been connected with New Zealand; or because Marsupial remains have been found in secondary rocks in Europe, and several species of opossums are living in America, these countries had also been united with Australia.

Speaking from a general point of view, I wish to add that the attempts to trace the geographical relations of a fauna and flora of a country can easily be exaggerated, and thus a theory be ridden to death which otherwise would be very useful. Moreover, an unfortunate country, such as New Zealand, of which a good number of the species of its fauna and flora show great resemblance to other species from distant countries, has to be dipped down and brought up again a great many times, in order to establish connections in various directions, so that a bird or fish, a shell, insect, or centipede, might cross from the one to the other without allowing, moreover, any other species from the same country to pass. Besides, the geological record of these islands at present at our disposal does not warrant us in assuming such repeated changes in the level of the land.

Can the explanation of such close specific resemblance not be found, in many instances at least, in the adoption of more simple natural causes, such as the transport by icebergs or on floating islands, by birds, etc., and of which Sir Charles Lyell, in his great work, the "Principles of Geology," gives many striking instances? However, where the theory of land connection is not admissible, and where also others, which have hitherto been applied, fail, might we not assume that similar climatic and other physical conditions could produce similar specific characters under the great law of evolution? It is a most difficult problem to say what constitutes a species, and therefore might it not be safer to believe, until the impossibility of such an hypothesis has been demonstrated satisfactorily, that there exists a similitude as well as an identity of species under certain given conditions?

In one word, might we not throw out the conjecture that in two more or less distant countries, which never were directly united, some forms of organic life can and do exist, which show what to us appear identical specific characters, because the cause or causes of their evolution were identical or nearly identical, and thus a considerable number of supposed changes in the level of many countries, of which we do not find geological records, can be dispensed with? It is true that instances to be explained by the migration or accident theories are of more frequent occurrence and more easily proved, but I think it would be just as interesting, where these cannot be admitted, to trace in all its bearings the similitude of species in distant countries. This view would at least open up a field of fresh research, and afford a new illustration and confirmation of the great theory of evolution.

Some discussion then took place on the address.

Mr. Maskell stated that he had undertaken on behalf of the society to write a history of Canterbury, but he had since come to the determination to give up the task, inasmuch as the Province was yet too young to permit of anything but a history of dry details being written.

OTAGO INSTITUTE.

FIRST MEETING. 11*th February*, 1873.

J. T. Thomson, F.R.G.S., Vice-President, in the chair.

New member. — The Right Reverend S. T. Neville, D.D., Bishop of Dunedin.

1. "On the Glacial Action and Terrace Formations of South New Zealand," by J. T. Thomson, F.R.G.S. (*Transactions*, p. 309.)

Considerable discussion took place on the geological and glacial hypotheses set forth in the paper, in which the Hon. Captain Fraser, Messrs. McKerrow, Gillies, and Beal took part. They were all opposed to the theory propounded, and argued that as a rule the transformation of the earth's surface was attributable to aqueous and volcanic agency.

Mr. McKerrow considered that the fact of the remarkable curve made in the course of a river's descent had been clearly brought out by the collating and comparison of the survey *data.* It was quite new to him.

Regarding a suggestion that the Whale Fishery in the far South Sea should be prosecuted in vessels belonging to Otago, Mr. A. Bathgate referred to the Act against the killing of whales along the shore in the calving season being allowed to remain a dead letter, and spoke in favour of the fitting out of whalers from Port Chalmers.

Mr. Gillies and Mr. P. Thomson said it was a venture which, properly managed, would bring enormous profits.

Mr. J. S. Webb mentioned that the Spectroscope ordered some time ago was on board the "Beautiful Star," and would be landed before next meeting. He believed it was one of the finest instruments that had ever crossed the Line.

SECOND MEETING. 24*th April*, 1873.

R. Gillies in the chair.

New member.—The Reverend E. G. Penny.

The Secretary reported the election by the Council of Mr. Purdie to the office of Curator and Librarian.

The Secretary laid on the table three copies of the Tri-daily Weather Map and the Tri-daily Bulletin published by the War Department of the United States, and sent by the Chief Signal Master, to whom a vote of thanks was passed for his courtesy.

The Secretary reported that the Book Committee had sent an order for additional books to the value of about £30, and for apparatus, to the value of about £20, to complete the spectroscope.

Resolved—That in future the Institute year end on 31st December, and that the annual meeting be held at the commencement of each year, instead of in July.

1. "On the Variation of the Declination of the Magnetic Needle in the Southern Portion of the Middle Island, and Remarks on the Desirability of Establishing Magnetic Observatories in New Zealand," by A. H. Ross. (*Transactions*, p. 3.)

Resolved—That the suggestions at the end of Mr. Ross' paper be sent to the Manager of the New Zealand Institute.

2. "A Visit to Sandymount District, Otago Peninsula, and a brief Description of some of its more prominent natural Features," by Peter Thomson.

(ABSTRACT.)

"The district comprises some of the best land on the Otago Peninsula, as well as some of the very worst. The coast line is a series of high, irregular cliffs rising to 400 or 500 feet above the sea, and forming here and there small bays and promontories, against which, the water being deep close in, there is always a heavy surf beating, even in fine weather. The district contains some magnificent scenery and some natural wonders of a very interesting nature." The author first visited the lime works, where, he says, "the lime is of excellent quality, the rock cropping out on the side of a low hill, and bearing marks of extensive and long-continued water action, being worn into curious deep holes now filled with clay." He then went along the side of a steep hill, through a heavy rock cutting of hard bluestone, to Sandfly Bay. The rocks there are very much broken and full of cavities, and the heavy waves dashed with prodigious force upon them. "The phenomenon known as the 'water-rocket' was frequent. Small masses of water are thrown up with great vigour, with tails of spray, just as if fired from a gun, often at right angles to the way the wave is moving. This is caused by the air being compressed in the hollows of the rocks by the advancing water, and, expanding rapidly when the pressure ceases in the hole, is blown through the wave into the air." At one end of the bay several stacks of rocks, called "Gull Rocks," stand at a short distance from shore, and are much frequented by sea birds. A bank of loose,

crumbling rock at the end of the beach is said to contain fossil shells. The point opposite Gull Rocks resembles at some places great beds of hard, black cinders, and at others hard, compact, ribbon-like masses, the strata being very much inclined. In the next bay is a large sandy cave, 120 feet in diameter, the result of the action of the sea at a former time, when the land stood at a lower level, which is the abode of numerous rabbits. Further on immense cliffs of black rock stand straight up from the water's edge to a height of at least 600 feet. The cliff then divides, forming a terrace, partly under cultivation, on the slopes around which the timber is being rapidly destroyed. "Away before us extended a huge gap in the ground, the bottom of which we could not see. To our left rose a high precipice of black basaltic pillars, from the base of which sloped gently down a beautifully green patch of low bush. The precipice extended on our front to the sea, the pillars being brownish coloured, standing perpendicularly, like the pipes of a great organ, and ranging from 35 to 50 feet in height, capped by a great thickness of amorphous basalt in several beds. Down to our right was a patch of sandy-looking rock through which the sea came rolling in through a great archway." Nearly in front of the arch is a large pyramidal stack of rock in deep water, rising to about 350 feet in a pretty regular cone, and frequented by numberless birds. From a lofty cliff an extensive view of the surrounding country was obtained, and "a short way down the other side of the ridge we came to a very curious piece of ground. There was no soil on it, but plenty of stones of all sizes. The south-west and north-east winds sweep over this tract of land with great force, and carry away every particle that is moveable, blowing it into the valley on either side ; the sand is thus kept perpetually passing, either one way or the other, over this arid belt. As a result of this motion all the stones are worn and polished into peculiar triangular shapes, something like those found in the wind-hollows among the sand-hills on the ocean beach near Dunedin."* Several species of *Raoulia* were gathered here.

2. "On the Skull of a Grampus killed by the Maoris at the Heads," by A. C. Purdie.

(ABSTRACT.)

This paper was a description of the *Grampus phocæna orca*† of Owen, which was killed at the heads by the Maoris, and obtained from them for the Museum by the Hon. Captain Fraser. It has a very formidable-looking head, and large laniariform teeth well adapted for tearing and destroying whales. The Maoris call them "killers," and say that they attack whales and tear out their tongues. The author had a photograph taken of this specimen, and forwarded it to Dr. Hector, in the hope that scientific men might take up the

* See Trans. N.Z. Inst., Vol. II., p. 247.—[ED.]

† *Orca pacifica*, Gray, Proc. Zool. Soc., 1870, p. 70.—[ED.]

subject and give some information regarding the animals frequenting our coasts, as there was great uncertainty regarding their history.

THIRD MEETING. 13*th May*, 1873.

R. Gillies in the chair.

1. Mr. J. S. Webb read a letter from Dr. Lauder Lindsay, F.R.S.E., relating to the proposed visit to New Zealand of the Swedish botanist, Dr. Berggren.

Resolved—That the Council be requested to take suitable steps to greet Dr. Berggren on his arrival in Otago, and to bring his intended visit under the notice of the Government.

2. "Salmon Acclimatization in New Zealand," by W. Lauder Lindsay, M.D., F.R.S.E., Hon. Mem. N.Z. Inst.

The introductory portion of this paper was read by Mr Webb.

(ABSTRACT.)

The author began by giving a history of his connection with the two experiments of 1867 and 1873. He then proceeded to enforce the importance of shortness of interval between the time of collecting the ova and their deposition in the breeding pond, and the necessity for speediness of transport, which can be obtained by substituting steamers for ordinary sailing ships; and, for the same reason, he urged the propriety of selecting California as the source of supply instead of Britain. He dwelt on the advisability of making a variety of experiments on means of preservation of ova, which would be calculated to secure greater certainty of result at a less expenditure than package in ice-houses on board ship; on the necessity for skilled supervision during the collection, transport, and hatching of ova; and on the importance of making due preparation for their reception in ponds constructed on suitable sites, and supervised by skilled superintendents. The possibility of transporting live parr or smolt, or even mature salmon, on short voyages, if placed in swing tanks or decked wells, was also suggested. The necessity for swinging the ova-boxes on gimbals, and so fixing their supports as to prevent upsets or violent jolts, was pointed out, as well as the importance of keeping the ova cool throughout the voyage by ice-cooling or refrigeration of the water or other substances in which they are imbedded; and the author finished by urging the propriety of extending the shipments over a series of years, so as to guard against any chance of failure. In the paper was interspersed a large mass of correspondence with many gentlemen, including some of the most eminent living authorities on the subject of salmon-culture.

Discussion was postponed till next meeting, before which time it was resolved that the paper should be printed and circulated.

Fourth Meeting. *8th July*, 1873.

The Rev. D. M. Stuart, D.D., Vice-President, in the chair.

New member.—John Douglas.

The discussion on Dr. Lauder Lindsay's paper on "Salmon Acclimatization in New Zealand" was postponed, as, owing to an accident, the paper had not yet been circulated.

1. "Philological Considerations on the Whence of the Maori," by J. T. Thomson, F.R.G.S. (*Appendix*, p. xxv.)

It was resolved that this paper be favourably recommended to the Governors of the New Zealand Institute for printing *in extenso* in the Transactions.

Fifth Meeting. *12th August*, 1873.

J. T. Thomson, F.R.G.S., Vice-President, in the chair.

New member.—Dr. Webster.

The Secretary laid on the table a complete Catalogue of the Library of the society.

1. "On a Smokeless and Self-feeding Furnace for Lignites and other Fuels, and the Utilization of the Waste Heat," by Henry Skey. (*Transactions*, p. 25.)

The Chairman said he should like to have seen some practical men there that evening. There was abundance of coal in the Province, and it would be a great benefit if it could be utilized as suggested by Mr. Skey. He was glad the matter had been brought forward, for it was certainly worthy of very serious consideration. He would ask the author if the principle could be applied to dwelling-houses.

The author replied that it could be so applied with certain modifications. It was, however, principally intended for the raising of steam. As furnaces were now constructed there was a very great waste of heat; and the same in the case of ordinary fire-places, where a large portion of the heat escaped up the chimney. It took about one-fourth the fuel to give the draught. Could his principle be carried out, not only would one-fourth be saved in the value of the coal consumed, but we should be able to use any species of coal or lignite for domestic, and especially for steam, purposes. But it was true that great difficulties were in the way of utilizing heat in the way he had pointed out.

The Chairman remarked that the subject was one that would get more important with a scarcity of coal. He would certainly like to see Mr. Skey's project a success.

Mr. Gillies would certainly like to see the matter tested, and a machine constructed on the principle referred to. He hoped the author would pursue his enquiries into this subject still further.

The Chairman had no doubt that if the principle was a beneficial one there would not be wanting practical men to take the matter up.

Mr. Skey, in answer to a question, said there was no doubt that under his principle the coal would burn away more rapidly, but as long as it gave out the same heat this would be all the better.

Mr. Gillies said that, when at the Mosgiel Woollen Factory lately, he had been informed that the Green Island coal was used there, and that there was no comparison between its cost and that of Newcastle coal.

The postponed discussion on Dr. Lauder Lindsay's paper on Salmon Acclimatization then took place.

Mr. Webb said that the information and suggestions contained in this paper were of a most valuable character. If proper waters were found for them he thought Salmon from North America could be acclimatized quite as well as from other countries. He hoped the suggestions of Dr. Ransom would be carried into effect.

Resolved—That copies of Dr. Lindsay's paper be sent to the Colonial Government, the Provincial Government of Otago, and the Acclimatization Societies of Canterbury, Otago, and Southland; and that attention be, at the same time, called to the information supplied in this paper as to the suitability of the Pacific Coast of British America as a source of supply; to the suggestion of Dr. Ransom for the conveyance of ova in ice-cold water in swinging vessels; and to that of Dr. Lindsay, that the experiment of Salmon Acclimatization ought to be persisted in for several years regularly under the superintendence of experts.

The Chairman spoke in favour of the Southland waters over the Molyneux, as the latter was now charged with silt.

Sixth Meeting. 11*th November*, 1873.

J. T. Thomson, F.R.G.S.. Vice-President, in the chair.

New member.—The Rev. Alexander Dasent, M.A.

His Honour Mr. Justice Chapman was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with Clause 7 of the New Zealand Institute Act.

The nomination for the election of Honorary Members of the New Zealand Institute was made in accordance with Statute IV.

1. "On Observed Irregularities in the Action of the Compass in Iron Steam Vessels," by A. H. Ross. (*Transactions*, p. 10.)

The Chairman then introduced Captain Hutton to the society, and, in doing so, dwelt upon the large field that Otago presented for scientific enquiry. For instance, the circumstances under which gold had been deposited at the Blue Spur had to him always been a perfect enigma. Captain Hutton would be able to investigate, and perhaps solve, this and similar enigmas, and his labours would bring the Province under the notice of *savans* in Europe, which could not but prove beneficial to it.

2. "List of the Insects recorded as having been found in New Zealand previous to the Year 1870," by Captain F. W. Hutton, C.M.Z.S. (*Transactions*, p. 158.)

The author said the list now offered was nearly complete. The difficulty in this matter was that the species were so numerous that no person would undertake the task of naming them all. The Beetles alone, for example, were more numerous than all the plants of New Zealand. The only way that he could see by which the task could be performed was for the General Government to place a sum, say £300, on the Estimates (as they did with the flora) to pay some young entomologist at home to collect into one volume, and translate the descriptions already printed, which numbered about 1,000. A beginning of the work of naming the species could then be made. As a preparatory step he had prepared the list in his hands. He had stopped at the year 1870 because there was no later copy of the "Zoological Record" in the colony, and he therefore could not feel sure as to what had been done. He concluded by again urging the Institute to bring its influence to bear on the General Government to vote the money required to pay some one to bring out a catalogue of all the genera and species of New Zealand insects already known.

Annual General Meeting. 17*th February*, 1874.

J. T. Thomson, F.R.G.S., Vice-President, in the chair.

New members.—Captain F. W. Hutton, F.G.S., C.M.Z.S., —. Johnston, D. Petrie, A. T. Thomson, G. Shrimpton.

The Annual Report and Balance Sheet were read and adopted.

The Secretary reported the arrival of additional Apparatus for the Spectroscope.

Election of Officers for 1874.—*President*—J. T. Thomson, F.R.G.S.;

Vice-Presidents—J. McKerrow, D. Brent ; *Council*—Professor Black, W. Blair, C.E., A. Bathgate, R. Gillies, Professor Shand, H. Skey, P. Thomson ; *Hon. Treasurer*—J. S. Webb ; *Hon. Secretary*—Captain F. W. Hutton.

1. "On the Mythology and Traditions of the Maori in New Zealand," by the Rev. F. H. Wohlers.

First Meeting. *7th April*, 1874.

J. T. Thomson, F.R.G.S., President, in the chair.

New members.—Dr. Bakewell, —. Mouat.

The President read the following anniversary

ADDRESS.

The first meeting of the Institute took place on July 20th, 1869 ; we are therefore approaching the fifth year of our existence. In looking over the papers published by the New Zealand Institute, of which this one is an affiliated society, I think it will be generally acknowledged that, after we have subtracted those written by the official or Government staff, our share of work has been fairly done ; not that I would have you to relax your efforts in the pursuit of knowledge, but that they may be redoubled.

On Natural History we have had papers by Messrs. J. S. Webb, A. C. Purdie, A. Bathgate, W. D. Murison, P. Thomson, and R. Gillies, also by Captain F. W. Hutton ; on Mathematics, by Messrs. Brent and R. Wilding ; on Archæology, by Dr. Eccles ; on Botany, by Mr. J. Buchanan ; on Physics, by Messrs. M. Chapman and J. S. Webb ; on Geology, by Messrs. J. M'Kerrow, and L. O. Beal ; on Physical Geography, by Mr. P. Thomson ; on Ethnography, by Mr. J. T. Thomson ; on Meteorology, by Mr. J. S. Webb ; on Engineering, by Messrs. G. M. Barr and Villaine ; on Mechanics, by Mr. J. T. Thomson ; on Astronomy, by Messrs. J. S. Webb and H. Skey. These papers appear in the first five volumes of the New Zealand Institute, but were principally given in the 3rd, 4th, and 5th.

In choosing me as the third person to hold the presidency, you were so good as to give a reason for this—viz., that I had done work. It is no doubt a gratification to me to find that the little I have done has been thus appreciated, and, apart from all personal considerations, I think the principle a fair one, to be occasionally upheld as an incentive to exertion on the part of other workers, members of this Institute.

Observation is the practical and scientific basis on which our minds can work, and the more accurate and extended this be, so much the more just and comprehensive will be our views and conclusions. The country in which we live naturally presents the most ready and interesting field for observation.

The materials are abundant, the subjects various, in its organic and inorganic productions. On the nature of these you are constituted a court of enquiry, and to that enquiry our Institute places no limits. Then enter on their study and investigation in as far as your time and opportunity may permit.

As I have now been connected with this Province for 18 years, and in the first term of that period, when it was in a state of wilderness, I had special opportunities given me for estimating its probable resources and productions, I may, without incurring much risk of the charge of egotism, refer to my opinions at that time, given as the result of observations obtained when exploring the physical geography of the country. There were, no doubt, others as fully alive to the prospects of the colony as myself, but I am not aware that they made any record of their observations for the benefit of the public in general.

Turning to a lecture delivered by me in Dunedin during the month of July, 1858, at which time the population numbered less than 7,000 souls, I find that, after showing the audience what extent of forest, pasture, swamps, lakes, and barren mountains we had, I made the following remarks:—"The value of our forests is less apparent at present than it would be in future times, but the great extent of natural pasture is a fund of wealth whose development will be rapid. The total area of natural pasture extends over 15,000 square miles, or 9,600,000 acres. This, when fully stocked, may be assumed to carry 2,400,000 sheep, whose fleeces alone will afford an annual export valued at £360,000 sterling—that is allowing four acres to carry one sheep, and the average weight of a fleece to be 3lbs. Nor need we anticipate that our export of wool will stop at this limit, for with the increase of population and capital our finest lands will be improved and laid under artificial grass, thereby increasing their productive powers five or ten-fold.

"More tardy in development, but not less important to the permanent welfare of the Province, is the agricultural interest. The progress of this branch of industry will so much depend on contingencies, as connected with immigration from the mother country that it would be useless to speculate on the rate of its extension. That our agricultural capabilities are great there can be no doubt, for corn is sown and reaped in all parts of the Province, stretching from the Waitaki to Foveaux Strait. On the banks of the Ohau Lake, 1,500 feet above the sea level, I have seen the potato growing in perfection; and, as I believe fully half the area of this Province is below that level, it will be a safe estimate to put down a fourth, or 4,250,000 acres, as capable of producing corn or vegetables.

"Whatever may be the ultimate population seeking support from the above area, in the meantime it is evident—possessing, as we do, a fertile soil and a climate analogous to Great Britain—that our pastoral and agricultural

products will be the same, equal in quality and as highly esteemed, whether they be wool, corn, or dairy produce, fresh or cured meat, or malt liquors.

"Our underground resources have been too little examined to permit of much speculation. That we have considerable and easily available coalfields is undoubted, and gold may be a valuable part of our exports."

No doubt my estimates, made at so early a date and while we as a colony were groping in the dark, are approximate, yet they were better than the estimates of those persons I saw at that time visiting Dunedin, who, looking at the snowy mountains behind Mount Cargill, shrugged their shoulders and took their passages by the next vessels sailing. The surmise of such was that Otago consisted of snowy mountains, whose appearance, in the language of a pioneer settler, was as a mass of sugar-loaves on a grocer's "bink."

Going to facts as we find them, it is interesting to note in the New Zealand statistics of 1871 that our wool export had increased to £689,182; our grain to £46,132;* and gold to £617,617 sterling, thus more than bearing out my anticipations; but of the latter I pretended to make no estimate. Yet the indication of the future was there, as I remarked that "gold might be a valuable part of our exports," and in giving this opinion I did not act without "observation." I had gone over most part of the Province in 1856 and 1857, excepting the Tuapeka district and the western snowy mountains. In doing so I had seen gold detected in the Mataura, very generally over the Waiopai Plains, as well as in the Lindis; and at the Nokomai the formation gave strong evidence of an auriferous nature, which fact I recorded in my field book. Yet I traversed the Hogburn (now Naseby), the Raggedy Ranges (now Blacks), and Flatcap (now Hamiltons) without anticipating the discoveries that have since taken place.

At the same time my much-respected assistant, Mr. Alexander Garvie, in whose survey party was Mr. John Buchanan, of Australian gold-mining experience and the actual prospector, traversed the Tuapeka district, extending his explorations up the Clutha Valley as far as the Kawarau Junction (now Cromwell). Over this area Mr. Garvie reported gold to be generally distributed, and probably payable by "some wholesale system of washing." It was on these *data* principally that I ventured on the suggestion. It was therefore founded on actual observation, and not made at haphazard.

Such was the state of the gold question in July, 1858, and, as subsequent events need not engage attention at present, I would refer those interested to

* As wool is almost entirely exported, while grain and agricultural produce are consumed at home, the statement, without remark, would leave an unfavourable impression. The statistics of this last year show the value of agricultural produce to be as follows:—Wheat, £372,250; oats, £300,300; barley, £66,000; hay, £32,000; potatoes, £60,000—£830,550 sterling.

the excellent report of Mr. Vincent Pyke, dated 1st October, 1862, where a very fair and full account has been given of the whole subject.

My observations and the deductions therefrom were those of a pioneering and exploring surveyor, engaged for the purpose of facilitating the operations of first settlement. Since then momentous events have taken place, the most marked of which was the great gold discovery of Mr. Gabriel Read in June, 1861, and which has contributed so much to the promotion of the material wealth of this part of New Zealand. But how the progress of Otago has affected science is the question that engages this Institute.

I may mention, in passing, that when Mr. Gabriel Read was in the act of weighing out to me the gold of his first claim, he prophetically remarked that the face of the country would henceforth be changed. And so it has. Enterprise in all pursuits and avocations has been stimulated, and what were then barren wastes have been converted into smiling plains of waving corn, and the valleys in the interior resound with the din of manual and mechanical industry. The Government, by the increase of revenue, was enabled to engage scientific and professional men from abroad in the various departments. First, as being purely scientific, are to be mentioned the observations and explorations by Dr. Hector, F.R.S., so widely spread over all parts of the Province, even to the most inaccessible places; and which have been since extended to all New Zealand. For Otago this great good was done, that the public had the advantage of the opinions of a scientific man, based on our text-word—actual "observation." They therefore obtained, by one competent mind at work, substantial results that never could be attained to by any number of unregulated, unauthoritative parties, however experienced particular individuals might be. During the few years that Dr. Hector was with us he not only illustrated the general geology of the Province and made maps of the same, but he also displayed to the public the nature of our mineral resources, their positions and comparative values—including gold, silver, copper and antimony, coal, lime, useful clays, etc. About the same time Mr. Vincent Pyke was engaged in organizing the Goldfields Department and promoting and recording new discoveries that electrified the public mind, at closely recurring intervals. To his care and supervision is due the Goldfields Map, used as a work of reference to the present day. Messrs. Swyer, Paterson, and Balfour, civil engineers, were also induced to come to this distant part of the world, and to them is due the initiation of many of our public works in general, railway, and marine engineering respectively. Now the railway system of New Zealand is making rapid strides here, carrying out works of great magnitude and difficulty, which when completed will promote intercourse between settlements widely separated and at present cut off by steep mountains and rapid rivers. The construction of the Oamaru breakwater—the design of

a local engineer, Mr. M'Gregor—must also be noticed, as it is a work of not only high scientific skill, but is likely to be a great success, and will form a type for many such other works round our coasts.

Nor has the profession more allied to the fine arts been neglected. The architectural beauty for which Dunedin is prominent has been due mostly to the labours of Messrs. Mason, Clayton, Lawson, and Ross. To proceed further in this direction would *appear* to lead us out of the domain of the Institute; but I think not, as our constitution allows us great latitude. It would be a serious oversight not to mention the manufacturing industries that have sprung up. Foremost, because the pioneer one, is the foundry of Mr. William Wilson, at which water-wheels of the largest size are constructed, also rock-boring apparatus, river gold-dredgers, pneumatic tubes for the same purpose, machinery for saw-mills, steam engines, winches, quartz-crushing machinery, winding and pumping gear for coal mines, wool-presses, etc. Here also the propelling shaft of the "Gothenburg" steamship was repaired, the steamer "Wallace" was built, and vessels of the same class up to 500 tons could be constructed were there water frontage.

To mention others by name would be invidious, as some would necessarily be omitted; but while there are other factories in the same branch capable of turning out the same material, how numerous are just now the factories devoted to other branches of industry—such as the manufacture of woollen cloths, leather, boots, shoes, soap, gas, candles, biscuits, sweetmeats, agricultural implements in general, ploughs, reaping machines, anchors, boilers, chains, boards, windows, sashes, and last, though not least, whiskey, gin, and ales, etc. The tall chimneys everywhere rising indicate that, in this part of the world, all the skilled trades have found a suitable and ever-increasing location. The owners of these are the true representatives of applied science, and this Institute would be all the more flourishing if we had more of them as members of it.

Nor have the pursuits which bring no money to their votaries been entirely neglected, though they return much heart's content—a great gain. Dr. Lauder Lindsay, of Perth, came this long voyage to collect and study the botany of our Province; and we have a scientific representative from Sweden here to-night in the person of Dr. Berggren. Mr. John Buchanan, for many years before he found official support, gave much of his time to the same department, and since which time he, I believe more than any other man, has explored the natural vegetation of this part of New Zealand, and illustrated the same by publication.

But we must not confine our attention to scanning ourselves alone; we must look abroad and observe the great movements that, through the influence of science and its applications, are going on in the world. Steam has stimulated

vast movements, the Press has given consistency to national effort, and the Electric Telegraph binds the world together. A mighty intelligence sympathetically moves all civilized peoples. The enthusiastic congratulate themselves that they live in the age of progress; the thoughtful see that it involves higher aims and responsibilities at the same time. The middle-aged man can now recount the labours of centuries within his own life's experience. Fifty years ago the United States was practically confined within the bounds of the Mississippi and St. Lawrence; now she stretches across the great American Continent, and binds her people on the two great oceans by a railway. Not less progressive, Great Britain since that time has conquered seven empires, and brought 100 millions of people under her sway. I allude to the Empire of the East. Forty-six years ago the first steamer made its voyage between Edinburgh and London, and I, amongst many thousand spectators, saw her pass my native place with my own eyes. In 1836 the second railway of Great Britain was completed, which joined the waters of the German Ocean and the Irish Sea. In 1838 three steamers only had reached India. The discovery of Œrsted was not yet developed into the electric telegraph, so it was at that time practically unknown. To navigate the Atlantic Ocean by steam was thought to be an impossibility. Ten years later, to join the Red and Mediterranean Seas by a canal was thought by almost all English engineers to be a chimerical scheme. Now, what have we by the aid of steam and science applied to the arts of war as well as peace? National exclusiveness has been broken down. Japan and China open their ports and interior districts, and their masses surge back upon us. In the face of life they react on their western brethren, and suffuse their nationality from centre to extremes.

In the year 1833 Earle gives a most circumstantial account of the killing, cooking, and eating of a young Maori girl by her own race. Was this not the shadow of coming events, an allegory of the certain fate of so inhuman a race? So, when we look at the great movements of the white races during these last two hundred years, and mark them by "observation," do we not dimly see other movements in process? The red-coloured man has been swept off the face of the northern continent of America, and so recent and rapid has this momentous fact been that even now is to be seen, on the shelves of the Boston Library, the Bible translated into one of their languages, which is now a dead one. The tribe has passed away. Then, what has made the white man—or more conspicuously the Anglo-Saxon—of the Teutonic race so ubiquitously progressive and aggressive; this more especially of so recent a date? It is his humanity and science, combined with steam. And what makes steam for him? It is coal. What then has coal to do with our race? As far as we know yet, everything. Then what will be the effect of coal on our status in the world? This is what is not clearly apparent to us as yet.

Coal, economically considered, is nothing else than stored-up heat, which science can make into power. Thirty-six years ago, Buddle, the eminent coal owner at Newcastle-upon-Tyne, estimated the supply of coal of Great Britain, at the then rate of consumption, equal to a period of 1,000 years. Recent authoritative investigation places it only at 200 years, showing, at the same time, that the United States of America have fifteen times the stores of Great Britain, and China eight times (the two largest fields in the world). It is evident then that the coal question is a more limited and temporary one with England than with America and China. Is she then right in allowing free trade in a limited product essential to her power? Or is it right to take the cosmopolitan view, and reply, that where Englishmen go there is England? Be that as it may, the most ample and readily accessible coal supply is in the hands of the red man, *i.e.*, the Chinese. Can he retain it, or will it pass out of his keeping in China, as it has passed out in America? Then which branch of the white race—the British, Russians, or Americans—will grasp the same, and by what routes? Oceanic—by the Red Sea, the Cape, or Pacific? Land—by Siberia, Tartary, or Hindostan? Or shall other white races possess this fund of power at present unused, when coal in this age of science is so essential to the power and existence of nations? These will become momentous problems to future generations, and have wide-spread influence on the movements of the human race. Certain it is that the people who have mere brute force and no science will in the long run succumb.

Then, in this remote corner of the globe, let us take a lesson from a great theme, and pursue the objects for which this Institute was established, viz., the cultivation of science; for science in this era more than ever supplies your necessities and protects your race. Nor be discouraged by the fewness of our numbers or the smallness of results, as compared with older countries, for we will enlarge with population, and, no doubt, do our fair proportion of service. Though our territory is not great, our climate is temperate, our atmosphere is bracing; so our people will be vigorous, and great Polynesia is before us.

The President read the report of the sub-committee appointed to communicate with the English and American Governments with reference to the approaching Transit of Venus.

1. A paper was read, containing Maori Traditions in the Native Language, by the Rev. F. H. Wohlers.

2. "On some Naturalized Plants of Otago," by G. M. Thomson.

Dr. Berggren, of the University of Lund, said that, although he had only been a short time in New Zealand, he was astonished to see how many introduced plants had spread and become naturalized, as it was so different from what he had been accustomed to in Europe. He had no doubt that

Mr. G. M. Thomson's list would soon be doubled; but some of the plants on that list he thought should be considered as New Zealand plants, such as *Polygonum aviculare* and *Sonchus oleraceus*. He had noticed in and near the rivers in Canterbury *Nasturtium amphibium* and *Anacharis alsinastrum*; these plants spread from America and Southern Europe into Northern Europe in exactly the same way. Most of these plants, he thought, would continue; and even the injurious ones would be more difficult to keep down by cultivation than they were in Europe, on account of good climate. With reference to the appearance and disappearance of thistles, he remarked that in Sweden, when the forest is cut down and burnt, *Geranium bohemicum* appears, no one knows whence; but in a few years it disappears, and never comes again. In the same way, when land is first broken up for cultivation, it comes, but soon goes again.

Captain Hutton exhibited a collection of Hepaticæ made by Mr. Kirk and himself on the Great Barrier Island.

Dr. Berggren remarked that the difference was very small between them and those that he had found in the South Island. In many of the New Zealand genera the development is not known, and the structure has not been studied; but when this is done it will throw great light on the classification of the order. He referred particularly to *Petalophyllum*, *Steetzia*, and *Symphogyna*.

Captain Hutton exhibited a sea trout (*Salmo trutta*) caught in Otago Harbour, and stated that another had been recently caught.

Mr. Webb stated that Mr. Young, of Palmerston, had informed him that 140 sea trout, hatched from Tasmanian ova, were turned into his pond early in 1871, of which about 120 were let into the river in 1872, and there could be no doubt that these were some of that lot.

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

First Meeting. 17*th March*, 1873.

J. Holloway in the chair.

A further supply of books from London was ordered.

Second Meeting. 8*th July*, 1873.

J. Holloway in the chair.

The Secretary reported the receipt of 64 copies of Volume V. of the Transactions of the New Zealand Institute for distribution to the members of the society.

Third Meeting. 8*th November*, 1873.

J. Holloway in the chair.

The Bishop of Nelson was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with Clause 7 of the New Zealand Institute Act.

The Secretary reported the receipt of new Books from London.

Fourth Meeting. 12*th November*, 1873.

J. Holloway in the chair.

New member.—C. P. Gabb.

The nomination for the election of Honorary Members of the New Zealand Institute was made in accordance with Statute IV.

FIFTH MEETING. 19*th January*, 1874.

J. Holloway in the chair.

The Secretary reported having handed over to the Nelson Institute during last year Books, principally of a scientific nature, of the value of £20 16s.

SIXTH MEETING. 21*st May*, 1874.

Leonard Boor, M.R.C.S., in the chair.

The Report and Accounts of last year were read and adopted.

ELECTION OF OFFICERS FOR 1874.—*President*—Sir David Monro; *Vice-President*—The Bishop of Nelson; *Council*—Leonard Boor, M.R.C.S., Charles Hunter-Brown, Hon. Thos. Renwick, Joseph Shephard, Geo. Williams, M.D.; *Hon. Treasurer*—J. Holloway; *Hon. Secretary*—T. Mackay.

The Secretary exhibited a green and brown spotted Lizard found by Mr. William Hunter on his run on the Upper Matakitaki, and which he had presented to the Association. The colours of this Lizard are much more vivid and quite different from any of the other specimens of the lizard species in the Museum of the Nelson Institute.

NEW ZEALAND INSTITUTE.

General Meeting. *20th September*, 1873.

His Excellency the Rt. Hon. Sir James Fergusson, Bart., President, in the chair.

FIFTH ANNUAL REPORT BY THE BOARD OF GOVERNORS.

Five years have now elapsed since the foundation of the New Zealand Institute, and this being the first occasion of a change of its official President, it affords an opportunity for a brief retrospect of the results which have been achieved through its instrumentality.

The chief object of the Act under which the Institute was incorporated was to promote the formation of societies in different parts of the colony for the collection and discussion of original observations concerning its natural history and resources. It was obvious that the geographical circumstances of the colony prevented the formation of any strong central society capable of stimulating and directing such investigations by frequent meetings of its members, as in other colonies that possess a chief centre of population, in which all social institutions become naturally concentrated. The constitution of the New Zealand Institute furnishes, therefore, a means of combining the efforts of provincial societies, at the same time relieving them of the great expense which they would have to incur in publishing their Transactions in an independent form. Experience elsewhere has shown that, in new countries especially, the funds of such societies are inadequate for the proper production of their Transactions, from the fact that the number of their members is few and the field for original observation is large, so that in a few years such societies are liable to decay, after accumulating much material that would be, if published, of great assistance in advancing our knowledge of the country.

Each scientific society in New Zealand that becomes affiliated to the Institute receives a share of an annual parliamentary grant, in proportion to the amount of work which is performed by its members, and the result is the production of a volume of Transactions and Proceedings that carries more authority, and does more credit to the colony, than could be derived from the publication of a number of detached pamphlets.

The form of constitution thus indicated has already evoked favourable expressions of opinion in some of the leading scientific journals of the old country, and it has even been seriously proposed that a similar institution should be established for consolidating the work of the different scientific societies scattered throughout Great Britain.

Although there is still much room for improvement, a comparison of the

five volumes which have now been issued shows that there is an increasing interest manifested in scientific pursuits, which must be attributed in a great measure to the influence which has been exerted by the publications of the Institute. Not only has the standard of the communications made to the societies greatly improved, but the demand which is everywhere expressed for elementary instruction in science evinces a desire on the part of the public to obtain as a branch of education the qualifications necessary for the comprehension and utilization of scientific literature, which is so characteristic a feature of the present age.

During the last five years 445 communications have been read before the different societies incorporated with the Institute, and 286 of these have been printed at length in the Transactions. With few exceptions all these papers relate directly to the colony, and place on record matters of fact and observations that otherwise would probably not have been published for many years to come. They comprise in round numbers about 120 papers on miscellaneous subjects, chiefly relating to ethnological considerations of the aboriginal race or connected with the industrial resources of the colony, 120 on Zoological subjects, 70 on Botanical, 53 on Chemistry and Metallurgy, and 60 on subjects relating to Geology and Physical Geography.

The information contained in these volumes is widely diffused beyond the limits of the colony, the chief libraries in all parts of the world being supplied with copies.

The number of members of the Institute has now increased from 256 to 563, the following being the numbers enrolled in the different incorporated societies :—

Auckland Institute	174
Wellington Philosophical Society	135
Otago Institute	113
Philosophical Institute of Canterbury	77
Nelson Association	64

During the past year four meetings of the Board of Governors have been held for the transaction of business, on 19th September and 13th November, 1872, and 21st February and 29th July, 1873.

Sir David Monro and Mr. W. T. L. Travers, F.L.S., were re-nominated Governors, and the Hon. Mr. Waterhouse and the Hon. Mr. Stafford were appointed on the retirement of Mr. Fitzgerald, C.M.G., and Dr. Knight, F.R.C.S.

The Governors elected by the Incorporated Societies for the present year were Mr. Justice Chapman, Mr. Rolleston, M.H.R., Captain Hutton, F.G.S.

In February, 1873, Mr. Ludlam resumed the office of Honorary Treasurer, which had been held during his absence from the colony by the Hon. Mr. Mantell.

The Foreign Members elected, in accordance with Statute IV., during the past year are—Sir George Grey, K.C.B., Professor Huxley, LL.D., F.R.S., Admiral Stokes.

A diploma of honorary membership was also conferred by the Board upon His Excellency Sir G. F. Bowen, G.C.M.G., accompanied by an address, placing on record an acknowledgment of his services for the advancement of scientific pursuits in the colony.

The attached statement of accounts shows the manner in which the funds at the disposal of the Board of Governors have been expended, leaving a balance of £181 13s. 3d. in hand at the close of the financial year.

The fifth volume of Transactions and Proceedings was issued in the month of May last. It contains 552 pages and 21 plates. 101 original communications were selected by the Board and printed either fully or in abstract in this volume; these are by 48 different authors, and consist of 33 on Zoology, 15 on Botany, 5 on Chemistry, 5 on Geology, and 43 papers on Miscellaneous subjects.

An arrangement has been made for the re-publication of the first volume of the Transactions, which is now out of print, only a small edition having been published; so that members who have joined the Institute since its first year may be able to obtain copies.

ACCOUNTS of the NEW ZEALAND INSTITUTE, 1872–73.

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
Balance in hand, August, 1872	195	13	5	Expenses of Volume V. - -	509	16	8
Vote for 1872-73 - - -	500	0	0	Miscellaneous — Translating, Binding, etc. - - -	25	3	0
Sale of Volumes of Transactions - - - -	21	0	0	Balance in hand - - -	181	13	3
	£716	13	5		£716	13	5

29th July, 1873. ALFRED LUDLAM, Hon. Treasurer.

ADDRESS to His Excellency Sir GEORGE FERGUSON BOWEN, G.C.M.G.

We, the Governors of the New Zealand Institute, feel it to be our duty, as well as pleasure, on the eve of your Excellency's departure from New Zealand, to convey to your Excellency our sincere acknowledgment of the interest which you have at all times taken in the advancement of scientific pursuits in the colony.

Especially we conceive it due to your Excellency to record the fact that your connection with the Institute has not been confined merely to the support

and countenance afforded by your Excellency's high official position, but that, in your capacity as its President, your Excellency not only contributed valuable addresses, which appear in its Transactions, but has at all times taken an active and zealous share in the direction and management of its affairs, and in the promotion of its successful career.

We feel justified in assuring your Excellency that the assistance which you have thus rendered will always be remembered with gratitude, not merely by those who feel a personal interest in scientific researches, but also by the colonists generally.

Reply from His Excellency Sir George F. Bowen to the Address presented to him by the Governors of the Institute.

Gentlemen—

I am very much gratified by the farewell address presented to me by you, and by the mark of distinction which you have conferred upon me in electing me to be an Honorary Member of the New Zealand Institute.

Any services which I may have been able to render are thus abundantly rewarded, and they were indeed a labour of love, for it is only simple justice to ascribe to me the most active and enduring interest in the welfare of the association of which I have had the honour of being the first President. Among the many agreeable recollections of this country which I shall always cherish, not the least satisfactory will be the memory of my connection with the Institute, and with the gentlemen who have formed with me its governing Board.

The chief aim of the Colonial Parliament in founding and endowing the Institute was not so much to make provision for the study and cultivation of art, science, and literature in general, but rather to supply guidance and aid for the people of New Zealand in the practical work of colonization. The yearly volumes of the Transactions and Proceedings show that this primary and essential object has been kept in constant view.

Rest assured, gentlemen, that I shall always remember you with respect and gratitude, and that I shall continue, although absent, to watch with lively interest the progress of the New Zealand Institute.

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1. "Lecture on New Guinea," by Captain Moresby, R.N., of H.M.S. "Basilisk." (*Appendix*, p. lxxxi.)

The lecture was an account of recent discoveries made by Captain Moresby in H.M.S. "Basilisk," and was illustrated by native implements, ornaments, musical instruments, and various curiosities, many of which had been presented to the Colonial Museum by Captain Moresby and his officers.

APPENDIX.

THE CLIMATE OF NEW ZEALAND.

METEOROLOGICAL STATISTICS.

The following Tables, etc., are published in anticipation of the Report of the Inspector of Meteorological Stations for 1873.

TABLE I. — Temperature of the Air, in shade, recorded at the Chief Towns in the North and South Islands of New Zealand, for the year 1873.

Place.	Mean Annual Temp.	Mean Temp. for (Spring) Sept., Oct., Nov.	Mean Temp. for (Summer) Dec., Jan., Feb.	Mean Temp. for (Autumn) Mar., Apl., May.	Mean Temp. for (Winter) June, July, Aug.	Mean daily range of Temp. for year.	Extreme range of Temp. for year.
	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.
North Island.							
Mongonui	61·8	59·2	69·2	64·2	—	15·6	54·0
Auckland	59·3	57·1	66·5	60·8	52·7	13·9	49·3
Taranaki	58·1	56·1	64·6	60·5	51·4	16·7	51·0
Napier	58·0	57·5	64·9	59·5	50·5	16·9	54·0
Wanganui	55·2	55·4	61·6	55·9	47·9	17·9	56·0
Wellington	55·4	53·7	61·1	57·4	49·4	11·9	45·0
Means, etc., for North Island	57·9	56·5	64·6	59·7	50·3	15·4	56·0
South Island.							
Nelson	56·6	55·8	64·4	57·6	48·4	22·2	58·0
Christchurch ...	52·9	52·6	61·2	53·4	44·4	14·4	60·0
Hokitika	53·7	49·5	59·7	55·3	46·9	12·9	49·0
Dunedin	50·6	50·2	56·9	51·3	44·1	13·8	50·0
Queenstown ...	50·8	50·3	59·2	51·8	41·1	16·4	58·2
Southland*	—	—	—	—	—	—	—
Means, etc., for South Island	52·9	51·6	60·2	53·8	44·9	15·9	58·2
Means for Nth. and Sth. Islands	55·4	54·0	62·4	56·7	47·6	15·6	58·2

* Returns not reliable.

TABLE II.—Barometrical Observations.—Rainfall, etc., recorded for the year 1873.

Place.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic Force of Vapour for year.	Mean Degree of Moisture for year.	Total Rainfall.	Mean Amount of Cloud.
North Island.	Inches.	Inches.	Inches.	Sat. = 100.	Inches.	0 to 10.
Mongonui ...	29·986	1·592	—	—	63·720	4·5
Auckland ...	29·981	1·596	·409	80	41·237	7·1
Taranaki ...	29·975	1·601	—	—	53·120	6·6
Napier	29·960	1·630	·375	77	42·380	2·6
Wanganui ...	30·053	1·550	·328	74	38·720	5·0
Wellington ...	29·942	1·540	·336	76	54·985	5·4
Means for Nth. Island	29·982	1·584	·362	77	49·027	5·2
South Island.						
Nelson	29·873	1·539	·342	72	65·440	5·6
Christchurch ...	29·940	1·639	·332	81	26·330	6·1
Hokitika ...	29·951	1·621	·348	83	96·170	4·4
Dunedin ...	29·786	1·723	·290	78	35·825	5·9
Queenstown ...	29·987	1·443	·249	67	32·300	5·4
Southland ...	29·886	1·730	—	—	37·480	6·8
Means for Sth. Island	29·903	1·616	·312	76	48·924	5·7
Means for Nth. & Sth. Islands	29·942	1·600	·337	76	48·975	5·4

TABLE III.—Wind for 1873.—Force and Direction.

Place.	Average Daily Velocity in miles.	Number of days it blew from each point.								
		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.*
North Island.										
Mongonui ...	146	14	27	51	52	11	96	34	66	14
Auckland ...	296	13	65	18	87	26	88	9	39	20
Taranaki ...	225	20	60	27	100	10	78	26	44	0
Napier ...	245	26	94	13	32	43	75	36	32	14
Wanganui ...	249	21	13	10	42	11	38	29	142	59
Wellington ...	215	28	13	14	126	3	13	6	158	4
South Island.										
Nelson ...	—	39	45	6	71	15	79	35	75	0
Christchurch .	138	5	97	51	39	21	105	1	39	7
Bealey ...	—	0	45	7	63	0	35	0	164	51
Hokitika ...	189	48	79	121	16	11	51	10	29	0
Dunedin ...	168	32	55	22	25	43	56	34	11	87
Queenstown ...	139	4	13	0	19	3	34	24	121	147
Southland ...	187	34	58	47	25	3	82	43	73	0

* These returns refer to the particular time of observation, and not to the whole twenty-four hours, and only show that no direction was recorded for the wind on that number of days.

TABLE IV.—Bealey,—Interior of Canterbury, at 2,104 feet above the sea.

Mean Annual Temp.	Mean daily range of Temp. for year.	Extreme range of Temp. for year.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic Force of Vapour for year.	Mean Degree of Moisture for year.	Total Rainfall.	Mean Amount of Cloud.
Degrees.	Degrees.	Degrees.	Inches.	Inches.	Inches.	Sat.=100.	Inches.	0 to 10.
47·7	16·9	69·8	29·757*	1·518	·280	83	82·070	5·2

* Reduced to sea level.

TABLE V.—Earthquakes reported in New Zealand during 1873.

Place.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Taranaki ...	...	..	...	...	...	...	5*	...	...	...	...	6, 8	3
Otaki ..	...	...	...	...	...	29*	...	...	...	...	...	...	1
Tarawera ...	...	...	...	...	...	...	...	...	18*	...	...	...	1
Opunaki ...	...	...	..	...	...	12	...	...	...	...	...	...	1
Patea ...	...	...	...	...	...	12	...	...	...	18*	...	8	3
Hawera ...	...	..	...	...	...	12	...	..	...	...	...	8, 16*	3
Napier ...	...	...	...	...	...	4	...	...	...	...	...	...	1
Wanganui...	6*	10	13, 16 23, 31	5	17, 19	8* 12 13, 18* 22* 29*	4, 5	29*	11* 21	18	...	8, 16*	23
Foxton ...	...	10	...	...	...	18* 29*	...	29*	...	...	...	16*	5
Marton ...	...	10	...	...	...	18*	...	...	...	...	...	...	2
Bull's ...	...	...	...	...	..	...	...	...	...	...	...	16*	1
Greytown ...	...	..	27	...	...	...	...	...	..	...	...	..	1
Wellington	...	...	17, 18 22	1* 14 17*	...	12	...	29	...	1	2	8, 16*	12
White Bay	...	...	...	...	...	12	...	29*	...	...	...	...	2
Nelson ...	26	...	24	1*	...	...	...	29	...	18*	...	8*	6
Bealey ...	...	...	...	...	...	...	...	24	...	...	...	...	1
Christch'rch	...	...	...	...	...	...	...	29	...	...	...	...	1
Havelock ..	...	...	...	...	...	...	...	...	...	...	2, 14	...	2
Kaiapoi ...	...	...	...	1	...	...	...	...	...	...	...	...	1
Timaru ...	26	...	...	..	...	...	...	...	...	...	...	...	1
Hokitika ..	4	...	...	...	..	...	...	...	...	...	...	...	1
Queenstown	31	...	...	...	...	...	...	...	...	...	...	...	1
Akaroa ...	...	...	...	...	...	...	...	...	...	23	...	...	1
Mana Island	...	...	16*	1* 17	...	12	...	...	...	...	...	8, 29	6

The figures denote the days of the month on which one or more shocks were felt. Those with an asterisk affixed were described as *smart*; those with a dagger as *severe shocks.* The remainder were only slight tremors, and no doubt escaped record at most stations, there being no instrumental means employed for their detection. This table is therefore not reliable so far as indicating the geographical distribution of the shocks.

TABLE VI.—COMPARATIVE ABSTRACT for 1873, and previous Years.

STATIONS.	Barometer.		Temperature from Self-registering Instruments read in Morning for Twenty-four hours previously.					Computed from Observations.		Rain.		Wind.		Cloud.
	Mean Reading.	Extreme Range.	Mean Temp. in Shade.	Mean Daily Range of Temp.	Extreme Range of Temp.	Max. Temp. in Sun's Rays.	Min. Temp. on Grass.	Mean Elastic Force of Vapour.	Mean Deg. of Moisture. (Saturation=100).	Total Fall in Inches.	No. of Days on which Rain fell.	Average daily force in Miles for Year.	Maximum Velocity in Miles in any 24 hours, and date.	Mean Amount (0 to 10).
NORTH ISLAND.														
Mongonui	29·986	1·592	61.8	15·6	54·0	154·0	—	—	—	63·720	158	146	672 on 6 Oct.	4·5
Previous 7 years	29·972	—	59·7	—	—	—	—	·417	76	52·868	167	—	—	—
Auckland	29·981	1·596	59·3	13·9	49·3	159·8	13·4	·409	80	41·237	170	296	780 on 8 Feb.	7·1
Previous 9 years	29·925	—	59·7	—	—	—	—	·413	76	45·432	187	—	—	—
Taranaki	29·975	1·601	58·1	16·7	51·0	—	26·0	—	—	53·120	181	225	630 on 6 Jan.	6·6
Previous 9 years	29·929	—	57·4	—	—	—	—	·373	73	57·001	157	—	—	—
Napier	29·960	1·630	58·0	16·9	54·0	140·0	—	·375	77	42·380	143	245	900 on 21 Jan.	2·6
Previous 5 years	29·909	—	58·2	—	—	—	—	·393	75	34·308	84	—	and 26 April.	—
Wanganui	30·053	1·550	55·2	17·9	56·0	149·0	—	·328	74	38·720	122	249	670 on 21 Jan.	5·0
Previous year	30·087	—	56·7	—	—	—	—	·333	71	38·120	135	—	—	—
Wellington	29·942	1·540	55·4	11·9	45·0	145·0	28·0	·336	76	54·985	173	215	845 on 18 Dec.	5·4
Previous 9 years	29·885	—	54·4	—	—	—	—	·328	72	50·416	154	—	—	—
SOUTH ISLAND.														
Nelson	29·873	1·539	56·6	22·2	58·0	169·0	—	·342	72	65·440	93	—	—	5·6
Previous 9 years	29·905	—	55·5	—	—	—	—	·370	75	62·368	88	—	—	—
Christchurch	29·940	1·639	52·9	14·4	60·0	160·0	13·5	·332	81	26·330	134	138	647 on 15 Jan.	6·1
Previous 9 years	29·864	—	53·8	—	—	—	—	·327	77	25·660	115	—	—	—
Bealey*	29·757	1·518	47·7	16·9	69·8	—	−7·0	·280	83	82·071	165	—	—	5·2
Previous 5 years	29·787	—	46·2	—	—	—	—	·259	81	100·621	178	—	—	—
Hokitika	29·951	1·621	53·7	12·9	49·0	106·0	22·8	·348	83	96·170	161	189	507 on 31 Aug.	4·4
Previous 7 years	29·930	—	52·5	—	—	—	—	·360	87	115·537	194	—	—	—
Dunedin	29·786	1·723	50·6	13·8	50·0	180·0	—	·290	78	35·825	167	168	670 on 29 Sept.	5·9
Previous 9 years	29·883	—	50·7	—	—	—	—	·279	73	32·711	166	—	—	—
Queenstown	29·987	1·443	50·8	16·4	58·2	155·7	—	·249	67	32·300	131	139	367 on 30 Sept.	5·4
Previous year	—	—	51·4	—	—	—	—	·257	67	28·880	117	—	—	—
Southland	29·886	1·730	—	—	—	156·0	—	—	—	37·480	191	187	580 on 24 Oct.	6·8
Previous 8 years	29·798	—	49·9	—	—	—	—	·274	75	46·817	156	—	—	—

* 2,104 feet above sea level.

Notes on the Weather during 1873.

January.—Unseasonable weather generally at all the stations during this month; heavy falls of rain, and frequently stormy, with thunder and hail; very wet in South. High atmospheric pressure on 30th, and very low on the 8th throughout; storm occurred on latter date.

February.—Excessive rain at some of the northern stations, with strong S.E. winds, but otherwise the weather was remarkably fine and dry, with light northerly winds; in the South, easterly winds with greatly reduced rainfall, especially in mountainous districts.

March.—The weather throughout was, on the whole, fine, with small rainfall and moderate winds; no storms of importance occurred at any of the stations; the average temperature for the month is high in nearly every case.

April.—Unusual prevalence of easterly weather, accompanied by excessive rainfall in the North and on the East Coast, while the rain was deficient on the West Coast and among the Alps.

May.—Mild weather throughout for season of year. In the North temperature above and rainfall below the average for previous years; prevailing winds westerly. In the South several storms, with snow, hail, and thunder.

June.—Remarkably fine, mild, calm weather, except on the West Coast of South Island, where it was frequently squally and wet; and at Wellington it was stormy in latter part of month. Temperature on the whole higher than average, and rainfall less than usual.

July.—Rainfall at some of the Northern stations in excess, but on West Coast and in the South it was considerably below the usual average, and the weather was tolerably fine for time of year. The prevailing wind throughout was from S.W., but no violent storms occurred. The temperature throughout was below the average, and frequently cold, severe weather occurred, with snow, hail, and thunder.

August.—The weather on the whole was mild throughout for the time of year, but the rainfall was in excess, and occasionally it was stormy and severe. Winds prevailed from westward. Very high atmospheric pressure at beginning of month, reaching to 30·54 inches, and about the 18th it fell to 29·2, when the weather was wet and squally throughout.

September.—The weather throughout was excessively wet and stormy. Westerly winds prevailed, and at some stations violent gales occurred, accompanied with severe thunder, heavy rain, and hail. In the extreme South, although the rain was excessive, yet the wind was not so strong.

October.—Occasionally stormy rough weather, but on the whole seasonable. In the North rain was in excess, and in the South considerably less than the average. The atmospheric pressure low throughout, and temperature about the average.

November.—Generally fine, pleasant, and seasonable, with a fair amount of rain; no storms of any note took place, but thunder was in some parts frequent.

December.—Seasonable weather during this month; temperature rather above the average, rainfall on the whole less than usual; prevailing N.W. winds, and at some stations strong gales occurred; exceedingly hot and oppressive at times.

*Philological Considerations on the Whence of the Maori.**

By J. T. THOMSON, F.R.G.S.

(Pl. I.–III.)

[*Read before the Otago Institute, 8th July,* 1873.]

IN approaching the question our stand-point is naturally in New Zealand, from whence the subject must be traced (if possible) to its end. Having already dealt with the same from an ethnological point of view,† I may remark that the study of words in tribes or nations has the same position in relation to the above science as the tracing of fossils has towards geology. One has its material as much imbedded in the people as the other has its in the earth—where one class is as much preserved for ages as the other is for epochs—and both may be dug out from their encasements and displayed to the present generation. The conclusions that we may draw from thence can only be stated after mature consideration.

The subject divides itself into three headings, viz., Glossarial, Idiomatic, and Phonetic; and as the first forms the easiest approach to what may prove a tedious and difficult enquiry, I will commence with it.

Primary words, *i.e.*, those that express first wants in men in their infancy—and, equally so, tribes or nations in their infancy—are the most tenacious of existence. These are common nouns, pronouns, and verbs, but more particularly the first—such as man, woman, son, daughter, food, fruit, fish, etc.; or, I, you, he, we, etc.; or, go, come, give, kill, etc. In elucidating a subject such as this, therefore, we apply our enquiries to primary terms, which we may denominate as the fossils of the languages, so that we may, from their coincidence or approximations in different and distant communities, weigh the affinities of race or blood in the communities themselves.

But while primary words are the most lasting, yet they even are subject to slow and gradual change as ages roll on. In English, Chaucer gives a ready example of this; and turning to the Portuguese, as one of the modern nations of Europe, who, more than any other, initiated the great spread of the

* In this paper I am indebted for assistance to the following works, viz. :—Malagasi Grammar, by Griffiths; Tamil Grammar, by Rhenius; Tongan Grammar, by West; and Maori Grammar, by Williams; Malayan Dictionary, by Marsden; Tongan Dictionary, by Mariner; Maori Dictionary, by Williams; Vocabularies of the Indian Archipelago, by Wallace; also of the Kayan Language (Borneo), by Burns; of the Timor Language, by Windsor Earle; of the Silong Tribe, by Ed. O'Riley; and some collections of words, by J. R. Logan, in Journ. Indian Arch.

† See Trans. N.Z. Inst., Vol. IV., 1871, p. 23.

Caucasian families over the earth, I have observed this change more aptly illustrated in different copies of the Lisbon and Colombo Bible. But another process goes on, both in single and separate tribes, that tends to divergence, *i.e.*, in their applying radical expressions to parallel and convertible ideas and objects; and confining ourselves to the regions over which this enquiry will extend, we give below some examples of such as have taken place amongst the various tribes scattered over the vast extent to which we are led. Thus, in Malay, *bunga* is the radical expression for flowers; by parallel it is applied to sparks—*bunga api*, the flower of fire; to rent *bunga tannah*, the flower of land. Again, in Malay, *bua* is the radical expression for fruit; by parallel it becomes cannon balls—*bua meriam*, the fruit of cannon; and by conversion it becomes flowers in Maori, viz., *pua*. Again, in Malay, *lima* signifies five; by conversion it becomes *lima*, the hand, in Salayer, Salibabo, Cajeli, and Lariki, tribes in the Moluccas; and by parallel it becomes *penglima*, an admiral, or hand of the sovereign. Finally, the word *mata* in Malay and several other languages, meaning the eye, has extensive application in this manner: thus, by parallel *mata ayer* means a fountain, or eye of water; *mata wang* means hard cash, or the eye of money; *mata hari* means the sun, or the eye of the day; while, by conversion, the same word *(mata)* in Maori becomes the face.

It will be seen that these primitive people have dabbled a little in political economy, for, while they call *bua wang* (the fruit of money) profit, they call *bunga wang* (the flower of money) interest. Whether this be correct science or not I ask the followers of Adam Smith to answer. So also, as naturalists, while they call *bua* fruit, they call eggs by the same expression, *i.e.*, the fruit of fowls—a hint that even Darwin might not take exception to. Some illustrations of the application of radical expressions applied to parallel or convertible ideas and objects:—

Buah or *bua*, fruit; *buah raga*, football; *buah pari*, dice; *buah chatur*, draughtsman; *buah pelu*, testiculi; *buah meriam*, cannon balls; *anak buah*, dependents of a chief; *buah permata*, jewels; *sa buah nigri*, one town; *sa buah ruma*, one house; *sa buah kapal*, one ship; *buah wang*, profit, in Malay; *pua*, flowers; *hua*, eggs, in Maori.

Bunga, flowers; *bunga pala*, mace; *bunga karang*, coral; *bunga api*, sparks; *bunga wang*, interest; *bunga tannah*, rent, in Malay; *bunga nea*, fruit, in Bolang-hitam.

Kaki, feet; *kaki*, legs; *debawah kaki*, at your disposal, in Malay.

Allah, the Almighty; *alah*, to overcome, in Malay; *ber allah*, an idol, in Bajow.

Hulu or *ulu*, the head of men or beasts, source of a river or of events, handle of a sword or knife, interior of a country; *ulu-nian*, aboriginal inhabitants; *bulu*, feathers, down, hair; *bulu mata*, eyelashes; *buluh*, bamboo cane; *de hulu*, before, in contradistinction to *de blakang*, behind; *pengulu*, a leader or chief on land, in Malay; *huru huru*, coarse hair; *huru*, brushwood, in Maori; *huru*, feathers, in Liang; *bulu*, feathers, and *uhu*, hair, in Salayer.

Lima, five; *penglima*, a leader at sea (an admiral); *lima*, the hand, in Salayer, Salibabo, Cajeli, and Lariki; also, *olima*, in Bouton; *rilma*, in Menado; *rima*, in Bolang-

hitam, Liang, and Saparua ; *lemnatia*, in Amblaw ; *limaka*, in Morella ; *limawa*, in Batumerah ; *limamo*, in Camarian ; *limacolo*, in Teluti ; *niman*, in Ahtiago ; and *limin*, in Teor.

Mata, the eye ; *mata ayer*, a fountain ; *mata pisau*, the blade of a knife ; *mata wang*, hard cash ; *mata banda*, property ; *mata jalan*, advanced guard ; *mata mata*, an overseer ; *mata hari*, the sun (literally the eye of the day), in Malay ; *mata alo*, the sun, in Salayer ; also, *mata roa*, in Menado ; *ria mata*, in Liang ; *lia mata*, in Lariki, etc. ; *mata*, face, in Maori.

Muka, the face ; *muka papan*, effrontery (literally, flat board-faced), in Malay.

Rupa, face, in Salayer ; *rupa*, likeness, in Malay.

Angkat, to lift ; *mang kat*, to die (applied only to princes) ; *anak angkat*, the adopted child ; *angkatan*, an expedition by sea or land ; *angkas*, ethereal space, in Malay.

Panas, warm, in Malay ; *bahaha*, in Cajeli ; *bafanat*, in Ahtiago ; *mahana*, the day, in Maori.

Hangat, hot, in Malay ; *hangat*, the sun, in Wayapo.

Mata hari, the sun ; and *mata*, the eye, in Malay.

Mata alo, the sun ; and *mata*, the eye, in Salayer.

Ria mata, the sun ; and *mata*, the eye, in Liang.

Lia matei, the sun ; and *mata*, the eye, in Morella.

Lia mata, the sun ; and *mata*, the eye, in Lariki.

Riamatani, the sun ; and *mata*, the eye, in Saparua.

Liamatan, the sun ; and *matan*, the eye, in Ahtiago.

Matalon, the sun ; and *mata*, the eye, in Bajow.

Kom-aru, the sun ; and *karu*, the eye, in Maori.

The above are a few examples of the tendencies to divergency in languages by operations within themselves ; but they are by no means so forcible as influences from without, caused by inroads of conquering tribes, mercantile communication, and the aptitude for borrowing expressions from more cultivated races, yet, notwithstanding, these primary terms in tropical, and indeed in other races, are all but irradicable, excepting by the extirpation of the people themselves. Of this fact most enquirers will have seen abundant proof.

The nearest cognate race to the New Zealand Maori is that which inhabits the Tonga or Friendly Islands. This group is sub-divided into three well marked sub-groups, viz., Tongatabu, Haabai, and Haafuluhao. Whether the middle group—Haabai—be the Hawaiki of the Maoris, and Tongatabu be the *roro*, or gate thereto, spoken of in their traditions, I will leave others to decide ; certain it is that the languages have a most remarkable affinity, when, after considering the above causes of deterioration, we find after the lapse of centuries of separation so much glossarial coincidence. Captain Cook properly remarks, "that they are but dialects of one tongue, having less divergence than many counties in Great Britain."

For the sake of comparison with the languages of the Indian Archipelago, I have adopted the same selection of words as is given by Mr. Wallace in his comparative vocabularies of that region, though there is some disadvantage in

this course, inasmuch as many objects are not known to the Polynesian races which are common in the archipelago, and some words do not express primary wants.

On examination of the list of words below, it will appear that in allowing for differences in articulation which has caused the elision or transposition of vowels and consonants, there are sixty-six of the hundred-and-two words common to both. Thus we have in Maori and Tongan respectively, *hua, fua,* fruit; *pai, mea,* good; *wera, vela,* hot; *rahi, lahi,* large; *wahine, fafine,* woman; etc. But in this list fifteen words have no expression either in one dialect or both, owing to the object not being known to them, such as deer, monkey, etc. Thus the ratio of common words to the whole should be as 66 : 87. It may be noticed, in passing, that the word for pig in Maori, viz., *poaka,* being radically the same as the Tongan term, *buaka,* must have been either preserved by tradition or introduced by natives of Polynesia after the advent of the European. This word, in its various modifications, has extensive range, *puaka, buaka, phua'a,* etc., and is supposed by J. R. Logan to be of Asiatic origin, as *phak,* Thibet; *phag,* Bhutan, Limbu, etc.; *wok,* Kyen, Champang, etc.; *wak,* Magar; *vak,* Naga, Garu; *piak,* Chepang.

Maori compared with 102 words in the Tongan Language.

English.	Maori.	Tongan.
Ant	Poko-rua	Lo
		Loa-ta
Ashes	Punga-rehu	Eefoo
Bad	Kino	Covi
Banana	—	Fooji
Belly	Kopu	Gete
Bird	Manu	Manoo
Black	Mangu	Ooli-ooli
Blood	Toto	Tawto
Blue	—	Ooli ooli
Boat	Poti ?	
(Canoe)	Waka	Vaca foccatoo
Body	Tinana	Tangata
Bone	Iwi	Hooi
Bow	—	Acow fanna
Box	Pouaka ?	Booha ?
Butterfly	Pepepe	Pepe
Cat	Poti ?	Boosi ?
Child	Potiki	Bibigi
Chopper	—	—
Cocoanut	—	Nioo
Cold	Makariri	Momoko
Come	Haere mai	How my
Day	Ao	Aho
Deer	—	—
Dog	Kuri	Gooli
Door	Tatau	Matapa
Ear	Taringa	Telinga
Egg	Hua	Foi manoo
Eye	Kanohi	Matta
Eyeball	—	Kano-e-matta
Face	Mata	Matta
Father	Matua-tane	Tammy
Feather	Hou	Fooloo
Finger	Matihao	Cow-nima
Fire	Ahi	Afi
Fish	Ika	Ica
Flesh	Kikokiko	Cano
Flower	Pua	Fooa
Fly	Ngaro	Lango
Foot	Waewae	Vae
Fowl	Heihei ?	Moa
Fruit	Hua	Fooa
Go	Haere	Aloo
Gold	Koura ?	—
Good	Pai	Mea
Hair	Huru huru	Low-ooloo
Hand	Ringaringa	Low-nima
Hard	Pakeke	Fefeca
Head	Upoko	Ooloo
Honey	—	—
Hot	Wera	Vela
House	Whare	Falle
Husband	Tahu	Ohana
Iron	Rino ?	Oocummea ?
Island	Motu	—
Knife	Maripi	Hele
Large	Rahi	Lahi
Leaf	Rau	Lo acow
Little	Iti	Chi
Louse	Kutu	Gootoo
Man	Tangata	Tangata
Mat	Takapau	Tacapow
Monkey	—	—
Moon	Marama	Mahina
Mosquito	Waeroa	Namoo
Mother	Whaea	Fae
Mouth	Mangai	Gnootoo

ENGLISH.	MAORI.	TONGAN.
Mouthful	—	Maanga
Nail (finger)	Maikuku	Gnedji nima
Night	Po	Bo-ooli
Nose	Ihu	Ihoo
Oil	Hinu	Lolo
Pig	Poaka ?	Booaca ?
Post	Pou	Bo
Prawn(cray-fish)	Koura	Oo-o
Rain	Ua, Awha	Ooha
Rat	Kiore	Gooma
Red	Makurakura	Coola-coola
Rice	—	—
River	Awa	Vy-oota
Road	Ara	Halla
Root	Aka-aka	Aca
Saliva	Huare	Anoo
Salt	Tote ?	Masima
Sea	Tai Moana	Tahi Mooana

ENGLISH.	MOARI.	TONGAN.
Silver	—	—
Skin	Kiri	Gili
Smoke	Au	Ahoo
Snake	Neke ?	Toge
Soft	Ata	Moloo
Sour	I	Mahe-mahe
Spear	Tao	Tao
Star	Whetu	Fetoo
Sun	Rah	Laa
Sweet	Reka	Hooo melie
Tongue	Arero	Elelo
Tooth	Niho	Nifo
Water	Wai	Vy
Wax	—	—
White	Ma	Hinahina
Wife	Hoa	Ohaua
Wing	Pakau	Capacow
Woman	Wahine	Fafine
Wood	Rakau	Acow
Yellow	Punga punga	Mello

N.B.—Mariner's "Vocabulary of the Tongan Language" has been followed here, and as it is in the old system of spelling, *oo* stands in it for *u*, *ow* for *au*, *c* for *k*, *y* for *ai*, etc. In copying the words from the above we have altered the orthography to the new system, though they stand here as given by their author.

We now come to a comparison between the glossaries of the Maori and those of the Indian Archipelago. A list is given below of nine English words, against which are put the various expressions in Maori; and after the latter are placed equivalents found amongst fifty-nine languages of the Indian Archipelago. It will be seen that in every case they have one, two, or more equivalents, even though the expressions vary. Thus, in the various expressions in Maori for the word "small," three were found in the archipelago—*iti, riki, moroiti;* and the words for fire, *ahi*, and water, *wai*, have very extensive range under various modifications. Of the following nine words, four only are Malay.

Maori compared with nine words in fifty-nine languages of the Indian Archipelago.*

ENGLISH.	MAORI.	—
1. Black	*mangu*	(*manga*, Malagasi)
	pango	*ngoa*, Batchian; *ngeo*, Rotti
2. Fire	*ahi*	*api*, Malay and thirteen other languages; *ahu*, Cajeli; *afu*, Amblaw; *uku*, Ternati and two others; *uhu*, Sahoe; *aow*, Liang and seven other languages; *hao*, Saparua and Camarian; *yafo*, Teluti; *yaf*, Ahtiago; *aif*, Gah; *hai*, Goram and three others; *ai*, Brissi and Savu
	kapura	*voor*, Dorey
	hatete	
	kanaka	
	mapura	*puro*, Bolang-hitam
	kora	
	maute	
	ngiha	
	pahunu	

* ? is appended when word is derived from modern European language.

English.	Maori.	——
3. Large	*nui*	*naaik*, Brissi; *naiki*, Vaiqueno
	rahi	*ilahe*, Awaiya; *ilahil*, Saparua
	tetere	
4. Nose	*ihu*	*iru*, Lariki; *iri*, Saparua; *ino*, Vaiqueno; *inur*, Teto E.; *niru*, Allor; *irung*, Sulor; *nirun*, Ké Islands; *irun*, Ratahan; *irong*, Javanese; *idong*, Malay and three others
5. Small	*nohinohi*	
	iti	*ki-iti*, Wahai; *ichi-ichi*, Ternati; *kitchil*, Malay
	paku	
	riki	*didiki*, Bajau
	hakahaka	
	moroiti	*mo-roit-i*, Wayapo
	pokeke	
	tupakipaki	
	mahake	
	makari	
	mero meroiti	
	wheto	
	whetau	
6. Tongue	*arero*	*kelo*, Goram; *weo*, Savu
7. Tooth	*niho*	*nio*, Saparua; *nifoa*, Matabello; *nifan*, Ahtiago
	rei	
8. Water	*wai*	*wai*, Salibabo and seven others; *woya*, Kaioa; *waiyr*, Gani and Mysol; *wehr*, Morella and four others; *wehl*, Batumerah, and three others; *waeli*, Awaiya and Camarian; *welo*, Teluti; *waiin*, Ahtiago; *waar*, Dorey; *ve*, Teto; *hoi*, Vaiqueno; *oii*, Brissi; *oee*, Rotti; *we*, Allor; *boi*, Bajau; *aer*, Salayer; *aie*, Sasak; *ayer*, Malay
	honu	*manu*, Bouton and Tomore
	katao	
	mote	
	ngongi	
9. White	*ma*	*ma-puti*, Bugis and three others; *ma-wuroh*, Ratahan and two others; *ma-bidah*, Kemah and Bantik.

The next list, as given below, contains 102 English words with their various expressions in Maori, to which are appended their equivalents as found amongst thirty-three languages of the Indian Archipelago. On examination it will be seen that, with the exception of sixteen words, all others have one or more of the several Maori terms displayed in some of these languages. Thus, the two expressions for rain in Maori are *ua* and *awha ;* the former is found in various languages as *uan*, *huya*, *ulah*, *hura*, *hulan*, and the latter as *oha* and *wao*. The approximations are too close (that is when not actually the same), and the divergences too gradual, to admit a doubt as to common origin.

The sixteen words that have not their equivalents consist principally of articles and objects not known in New Zealand prior to the coming of the European, such as *banana*, *chopper*, *cocoanut*, *honey*, etc. Thus eighty-six words out of 102 are common between Maori and the languages of the Indian Archipelago, as against sixty-six words out of the same, common between Maori and Tongan. Then, as the latter are dialects of admittedly one language, the affinity of Maori glossaries to more distant races has forcible exposition, and

SUMATRA
MALAYA PROPER
Malacca
Singapore
Menangkabow
BORNEO
CELEBES
BUGIS PROPER
Macassar (Bugis)
Salayer
Bouton
JAVA
Batavia (Javanese)
Menado
Bolang-hitam ?
Sanguir
Salibabo ?
Molucca Islands.
Ternate
Tidore
Galela
Gani ?
Batchian
Weigiou
Salawatty
Mysol
NEW GUINEA
Dorey
CERAM
BOURO
Waihai
Gah ?
Goram
Matabello
Teor
Keh Is.
Aru Is.
Wokan
Tenember
Larat
Timor Laut
Babber
Serwatty
Wetter
Kissa
TIMOR
Brissi
Solor
Allor
Rotti
Savu
Suta
NOTE. Malays and Bugis are the traders of the archipelago, and have settlements in various parts, from the Malacca Straits, to New Guinea.
Scale of Eng. Stat Miles.

it should not escape remark that of the 102 words compared, nineteen of these only are Malay, the great majority belonging to the groups of Molucca, Ceram, and Timor, situated at the east end of the archipelago. Hence a glossarial link is clearly proved *viâ* Tongatabu, expressively called in Maori tradition the *roro*, or gate to Hawaiki, their home country, wherever that had been.

Maori compared with 102 words in thirty-three languages of the Indian Archipelago.*

ENGLISH.	MAORI.	—
Ant	*pokorua*	
Ashes	*pungarehu*	*orapu*, Bouton
Bad	*kino*	*hina*, (low) Malay
Banana		
Belly	*kopu*	*kompo*, Bouton
	manawa	
	takapu	
	riu	
Bird	*manu*	*manu*, Menado and five others ; *manok*, Javanese and eight others ; *manui*, Cajeli and Awaiya ; *manuti*, Wayapo and Massaratty ; *manik*, Gani ; *malok*, Wahai
	topatopa	
Black	*mangu*	*manga*, Malagasi
	pango	
Blood	*toto*	
Blue		
Boat	*poti ?*	*oti*, Tidore ; *lopi*, Salayer ; *owe*, Mysol
Body	*tinana*	*nanau*, Amblaw ; *nana-ka*, Liang ; *anana*, Lariki
Bone	*iwi*	*hoi*, Sula ; *riri*, Saparua ; *nili*, Camarian
	wheua	
Bow		
Box	*pouaka ?*	
Butterfly	*pepepe*	*pepe-ul*, Morella
Cat	*poti ?*	
	ngeru	*ngeau*, Bolang-hitam
	tori	
Child	*potiki*	
	tamaiti	
	kohungahunga	
	tahake	
Chopper		
Cocoanut		
Cold	*makariri*	*makariki*, Ahtiago ; *mariri*, Wahai ; *giridin*, Mysol; *aridin*, Matabello ; *periki*, Liang and Morella
	matao	
	matoke	
	hotoke	
	anu	
	hauaitu	
	hoto hoto	
	kopeke	
	korohawini	
	kowanu	
	kuiki	
	kutao	
	maeke	
Come	*haere mai*	*mai*, Lariki and six others ; *mari*, Malay
	ahu mai	*omai*, Cajeli and Batumerah ; *ikomai*, Wayapo ; *gumahi*, Massaratty ; *uimai*, Liang ; *oimai*, Morella

* ? is appended when derived from modern European language.

English.	Maori.	——
Day	*ao*	*ao-aaoa*, Lariki; *heo*, Bouton; *allo*, Salayer
	mahana	
	ra	*rau*, Menado; *lau*, Bajow
Deer		
Dog	*kirehe*	
	kuri	
	nane	
	peropero	
Door	*tatau*	
Door-post	*tuturu*	*metouru*, Lariki; *metoro*, Saparua
Ear	*taringa*	*talinga*, Malay and four others; *telilan*, Cajeli; *linga-nani*, Massaratty; *terina*, Liang and four others
Egg	*hua*	*munte-loa*, Batumerah; *mantir-hui*, Morella
Eye	*kanohi*	
	karu	*lau*, Tidore
Face	*mata*	*mata-lalin*, Wahai; *mati-noin*, Teor; *muti-no*, Mysol
	kanohi	
Father	*pa* *papa*	*bapa*, Malay and Gani, *baba*, Javanese and Tidore
	matua tane	*tua* (elder) Malay
Feather	*hou*	*owhu*, Bouton; *huru*, Liang
	raukura	
Finger	*matihao*	
	matikara	
	koikara	*kokowa-na*, Sula; *kukur*, Wahai
Fire	*ahi*	*ahu*, Cajeli; *efi*, Matabello; *api*, Malay and three others; *yaf*, Teor; *yap*, Mysol; *hao*, Saparua
Fish	*ika*	*ikan*, Malay and five others; *iyan*, Liang and nine others; *ein*, Mysol
	ngohi	
Flesh	*kikokiko*	
Flower	*puawai* *pua* *puaka*	*buah* (fruit), Malay
Fly	*ngaro*	
	rango	*rango*, Bolang-hitam; *lango*, Sanguir; *langow*, Bajow; *ralngoh*, Menado
	hurangi	
Foot	*waewae*	*oei*, Bouton; *raedai*, Menado; *laidi*, Sanguir; *wed*, Gani; *aiva*, Batumerah; *ai*, Lariki and six others; *matwey*, Mysol
Fowl	*heihei* ?	
	te kaokao	*tekay-ap*, Mysol
Fruit	*hua*	*hua*, Liang and two others; *ai-hua*, Lariki; *huwai*, Camarian; *huan*, Teluti; *vuan*, Tobo; *phuin*, Teor; *bua*, Malay and five others; *wowoan*, Javanese; *fuan*, Wayapo and Massaratty; *buani*, Amblaw; *aihuwana*, Batumerah
Go	*haere*	*ai*, Saparua
	ngawi	*awai*, Batumerah
	tiki	*takek*, Teor
	whiu	*aeo*, Awaiya and Camarian
	whana	*fanow*, Matabello
Gold	*koura* ?	
Good	*pai*	*bai*, Malay; *baji*, Salayer; *pia*, Sula; *parei*, Amblaw; *fiar*, Gani; *ia*, Liang and two others; *mai*, Lariki and Camarian; *fei*, Mysol
	purotu	
Hair	*huruhuru*	*uhu*, Salayer; *hutu*, Tidore and Galela; *uwohoh*, Saparua; *ulufuim*, Ahtiago
	makawe	
	mahunga	
	whakahipa	

ENGLISH.	MAORI.	—
Hand	*ringaringa*	
Handful	*kutanga*	Tongan, Malay, and two others, for hand
Hard	*maro*	*muru-goso*, Bolang-hitam
	pakeke	
	pakari	*kras*, Malay and two others
	pahohea	
	papa	
	totoka	
	utonga	
Head	*upoko*	*oyuko*, Teluti; *obaku*, Bouton; *uruka*, Liang and Morella
	matenga	
	mahunga	
	karu	*kahutu*, Mysol; *uru*, Saparua and Awaiya
	anga anga	*nanga-sahi*, Galela
	karaua	
	ngoto	
	pane	
	pareho	
	parihirihi	
	whakahipa	
Honey		
Hot	*wera*	*pelah*, Mysol
	pawera	
	pakakinakina	
House	*whare*	*balry*, Menado; *boré*, Bolang-hitam
	wharepuni	
	koropu	
Husband	*tahu*	*tua*, Sula; *nau*, Tidore
	tane	
Iron	*rino ?*	
	maitai ?	
Island	*motu*	*li-wuto*, Bouton; *ri-wuto*, Bolang-hitam
	maheno	
Knife	*maripi*	*iliti*, Cajeli
	mikara	
	kota	
Large	*nui*	*moughi*, Bouton
	rahi	*lehai*, Cajeli; *ilahe*, Awaiya
	tetere	
Leaf	*rau*	*laun*, Saparua; *ai-rawi*, Lariki; *daun*, Malay, and four others
	pakawha	
Little	*nohinohi*	
	iti	*ki-iti*, Wahai; *kidik-idi*, Bouton; *ro-it*, Wayapo
	paku	
Louse	*kutu*	*kutu*, Malay and nine others; *kota*, Sula; *koto*, Wayapo and Massaratty; *uru* and *utu*, Amblaw and nine others; *hut*, Teor; *ut* and *uti*, Mysol
Man	*tangata*	*tau-mata*, Menado; *tomata*, Salibabo; *tumata*, Saparua and two others
Mat	*takapau*	
	tapau	*tepoh*, Bajow; *tupur*, Salayer
	wharariki	
	koaka	
	tienga	
Monkey ?		
Moon	*marama*	*ora*, Tidore
Mosquito	*waeroa*	*owei*, Mysol
Mother	*matua-whine*	*ma* (mother), *tua* (old), *bini* (wife), Malay
	whaea	*yaiya*, Tidore
	koka	
	whaerere	

English.	Maori.	——
Mouth	*mangai*	*nanga,* Bouton ; *nganga,* Bolang-hitam
	waha	*bawa,* Salayer
	mawhera	
Nail(finger)	*maikuku*	*kuku,* Malay and three others ; *kanuka* or *kanuko,* Menado and three others ; *wuku,* Gah
Night	*po*	*po-tu,* Saparua ; *po-tuun,* Ahtiago
	kengo	
Nose	*ihu*	*iru,* Lariki
Oil	*hinu*	*mina,* Bouton
Pig	*poaka ?*	
	kuhukuhu	*hahu,* Morella and five others
Post	*pou*	*fao-lnim,* Ahtiago
	turupou	
Prawn } crayfish ? }	*koura*	*uran,* Javanese and three others
	waerau	
Rain	*ua*	*uan,* Gah ; *oha,* Bolang-hitam ; *huya,* Sula ; *ulah,* Amblaw ; *hura,* Galela ; *hulan,* Liang ; *huran,* Bajow ; *ujan,* Malay
	awha	*wao,* Bouton
Rat	*kiore*	*karufei,* Gah
	maungarua	*fud-arua,* Teor
	inamoki	
	riroi	
Red	*whero*	*merah,* Malay and four others
	kura	
	makurakura	
	paka	*kao,* Liang and five others
	pakaka	
	ngangana	
	pakurakura	
	towhero	
Rice ?		
River	*awa*	*uve,* Bouton ; *sawan,* Sanguir
Road	*ara*	*dara,* Bouton ; *lora,* Bolang-hitam ; *aya,* Sula ; *lalan,* Morella and three others ; *lahan,* Liang ; *laran,* Matabello ; *jalan,* Malay
	huarahi	
	huanui	
Root	*aka-aka*	*akar,* Malay and three others ; *wa-ata,* Liang ; *ai-aha,* Matabello
	weri	*hai-waari,* Camarian
Saliva	*hauare*	
	huare	
Salt	*tote ?*	
Sea	*moana*	
	tai	*tahi,* Matabello ; *tasi,* Ahtiago
Silver ?		
Skin	*hiako*	*oko-nen,* Massaratty
	kiri	*kine,* Mysol
Smoke	*paoa*	
	au	*aow-pot,* Lariki ; *aowaht,* Morella
	auahi	*yaphoi,* Mysol
Snake	*neke ?*	
	nakahe ?	
Soft	*ata*	
	mariri	
Sour	*I*	
	kawa	
	tangeo	

ENGLISH.	MAORI.	——
Spear	*matia*	
	tao	*taha*, Liang
	kokiri	
	hoata	
	kaukau	
	timata	
Star	*whetu*	*bituy*, Menado ; *fatui*, Sula ; *betol*, Gani ; *toi*, Ahtiago
Sun	*ra*	*ria-mata*, Liang ; *matarou*, Menado ; *lia*, Massaratty
	mamaru	
	komaru	
Sweet	*reka*	
Tongue	*arero*	*arau*, Mysol
Tooth	*niho*	*nio*, Saparua ; *nifoa*, Matabello
	rei	
Water	*wai*	*wai*, Ahtiago, Tobo, and six others ; *wai-im*, Ahtiago, Alfuras ; *waili*, Cajeli and two others ; *wayr*, Mysol ; *ayer*, Malay
	honu	
	katao	
	mote	
	ngongi	
Wax ?		
White	*ma*	*mabida*, Menado
Wife	*wahine*	*wewina*, Teor ; *babineh*, Salibabo ; *pipina*, Saparua ; *invina*, Ahtiago ; *bini*, Malay
	hoa	*foya*, Tidore
Wing	*parirau*	*pani-dey*, Menado ; *pori-pikia*, Bolang-hitam ; *fanik*, Teor
	pakau	
	pakakau	
	paihau	
Woman	*wahine*	*bawine*, Bouton ; *makoweni*, Sanguir ; *mahina*, Liang and four others ; *mewina*, Teor ; *vina*, Ahtiago
Wood	*rakau*	*okao*, Bouton ; *kao*, Sula and three others ; *kai*, Teor ; *kayu*, Malay and three others ; *kaju*, Salayer
Yellow	*punga-punga.*	

Being thus done with the Malayo-Polynesian glossarial connection, before we proceed in our enquiries it is necessary to mention that the Silong tribe of the islands of Mergui, near Burmah, are the furthest north-westward having distinct affinity with the above families. The negro islanders of Andaman are known to be ideologically connected, but their language, as far as I have gathered, has been too slightly investigated for final opinion. At Mergui, therefore, practically ends the influence of the peculiar phase of fossil words that we have been considering. Beyond this point the vast area of South Asia is met with, where now, at this period, Thibetan, Arian, and Semitic languages cover the space; and it is not till we come to the great island of Madagascar that we find traces of the material of which we are in search.

Captain Cook, the renowned navigator, indicates this fact as a circumstance known at his time. After him Humboldt supports the hypothesis of the language of Madagascar being identical in construction with those of the Indian Archipelago, but how far that great authority had analysed the languages is unknown to me. The bare fact of his support is all the information that I have been able

to gain. Subsequent writers discourage the idea, and the latest that I have been able to consult (Griffiths) says the following of the connection :—"The Malagasi bears some analogy to the Malay and the Arabic in the sound and signification of many of the words, and in the inflection of certain verbs; but to say that on this account it is a dialect of either the Malay or the Arabic would be as unreasonable as to say that the Arabic is a dialect of Hebrew, or the Hebrew a dialect of the Arabic." On reading this opinion the thought struck me that, as from my own personal knowledge the Malay has no affinity to Arabic, the author in comparing Malagasi to two dissimilar things might not have investigated either with the completeness necessary; so, in taking up Ellis' "Madagascar Revisited" and opening its pages at random, I was struck with the strong resemblance of the beautiful woodcut giving the portrait of a native, to the common cast of countenance found in the Indian Archipelago amongst the Bajow, or Sea Malays. A copy of this (Pl. I.) I am enabled to show to the Society through the skill of Mr. Alexander McColl, who has transferred it by the photo-lithographic process. Dipping further into the work I found almost every fifth word to have Malayan affinities, and coming to the capital, which I may take by way of example, I found it called *Antananarivo*, or the City of a Thousand Towns or Villages. Now, allowing for the differences of articulation, this is precisely the same as the Malay word *Tana-saribu*; the word *tanana* in Malagasi, denuded of the prefix, being used in a more restricted sense than it is generally in Malay—though even here a Malay uses the word in a very restricted sense occasionally, as when he talks of his *tana bindang*, or rice plot; *tana campong*, his village area, etc.

Thus led on, I was induced to proceed with picking out the word fossils of the language, *i.e.*, so far as the excellent grammar of the Rev. Mr. Griffiths afforded material. Out of this work I collected 146 words, as given below, ninety-five of which proved to be Malayan, and eighty Malayo-Polynesian. Of the list of words twenty-nine only had no equivalents. Of course it would be improper were I not to remark that primary words alone were selected, and not the secondary or tertiary that are given in all dictionaries. Again, comparing the Malagasi words given below that are also found in Wallace's and Earle's comparative vocabularies of the Indian Archipelago, I found that of forty-seven words forty-two had their equivalents in one or other, or several, of the dialects and languages. Thus in the primary words—in the bases of their languages—close affinity is clearly indicated.

Instancing particular words in Malagasi, it is interesting to examine their dispersion. Thus the word *vorona*, bird, is found in the Indian Archipelago slightly altered to *burong*, *urong*, etc., but the most usual term is *manok*, *manu*, *manik*, *mano*, etc. The former term is African, the other Asian; and in examining the various vocabularies we see that one seems to have striven to

Photographed by Rev. W. Ellis.

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RAINITSONTSORAKA.

Christian Martyr.

displace the other, the Asian one being the more victorious. The word *volo*, hair, is found nearly perfectly preserved at Massaratty and Wayapo, near Ceram, as *olofolo* and *folo* respectively. In Tonga it is *fulu ;* in New Zealand, *huru ;* and in Malay, *bulu ;* in Africa, *vulu ;* and in Asia (Thibet), *pul.* The two words *vava* and *mur*, the mouth, have each their preservers—(1st) in New Zealand, *waha ;* in Viti (Feejee), *fafa ;* in Bouton, *bawa ;* in Wokan (Arru), *fafahi ;* (2nd) in Kaffraria (Africa), *mlumu ;* and in Malaya, *mulut.* Lastly, the words *nif*, *nifo*, tooth, have been nearly extirpated in the Indian Archipelago, but are preserved in New Zealand, as *niko ;* in Tonga, as *nifo ;* in Matabello, near Keh Islands, as *nifoa ;* etc.

One hundred and forty-six words of Malagasi compared with Malayan, Maori, and Tongan Dictionaries, to which are added some African and East Indian cognations.

ENGLISH.	MALAGASI.	MALAY.	——
Answer	valy	bali jawab	
Axe	famaky, vilahy, famatsika	bliung (adze)	
Anger	tezitra	stru (enmity)	*aritarita*, Maori
Abuse	ompa	ompat	
Beast	biby	babi (swine)	
Black	munga	—	*munga*, Maori
Blood	ra, rany	dara	*ra'aru*, Kissa
Belly	kibo	—	*kopu*, Maori ; *kabin*, Teor
Bird	vorona	burong	*burong*, Salayer and Batumerah ; *urong*, Sunda
Bad	ratsy	—	*ahati*, Wahai ; *rahat*, Bajow and Matabello
Bone	toalana	tulang	
Body	vatang	badan (body), batang(trunk)	*watan*, Matabello ; *fatan*, Wayapo ; *badan*, Sanguir ; *padan*, Mysol
Cattle	omby, aombe, fiary, angumbi	domba (sheep)	*lombe*, *gnombai*, Sauhili (Africa) ; *'gombi*, Kwillimani
Child	zanaka, anaka	anak	*anak*, Javanese and five others
Cloth	lamba, sembo, siky	—	
Cry aloud	minene	menyeni (sing)	
Charm	ody, oly	obat	*ocoe*, Tongan
Change	ova	uba	
Cow	angumbe	—	
Done	efa	—	
Day	andro	—	*ao*, Maori ; *aho*, Tongan ; *allo*, Salayer ; *dowa*, Wayapo ; *rou*, Menado
Dead	maty	mati	*mate*, Maori and Tongan ; *maki*, Kissa
Drink	sotro, minona	minum	*inu*, Maori and Tongan ; *nomon*, Kissa
Dung	vela	bera	*wairakau*, Maori
Dog	amboa, kivahy, fandroaka	—	*kirehe*, Maori ; *muntoa*, Bouton ; *ahua*, Kissa ; *yahoa*, Keh ; *ambua*, African ; *aai*, Silong

NOTE.—*y* in Malagasi terminations has same sound as *i* in other words.

English.	Malagasi.	Malay.	——
Earth	tany	tana	*one-one*, Maori; *tana*, Kayan
Ear	talinhe	telinga	*taringa*, Maori
Eye	maso	mata	*mata*, Tongan; *moto*, Javanese; *macho*, Sauhili (African)
Fire	afo	api	*ahi*, Maori; *afi*, Tongan; *afu*, Amblaw; *aow*, Liang and five others; *apoi*, Silong
Forest	ala	—	
Fish	loa*ka*	i*kan*	*ika*, Maori and Tongan; *iwak*, Indonesia. (Roots: *ka*, Siam; *in*, Teochew) *akan*, Silong
Food	hanina	ma*kanin*	
Full	feno	puno	*peno*, Kissa
Filth	loto	kotor	
Fruit	voa	boa	*hua*, Maori; *fua*, Tongan; *vuan*, Ahtiago; *woya*, Gah; *fuan*, Wayapo
Flowers	vony	bunga	*woini*, Kissa
Feet	tongon	tangan (hand)	
Father	ray	—	*hunarei*, Maori; *amay*, Kayan
Friend	sakaiza	—	
	longo		
Fear	tahotra	takutan	*mataku*, Maori
Good	tsara	—	*ala*, Bajow; *laha*, Tidore; *saya*, Kayan
Growth	tombo	tumbo-an	*tupu*, Maori; *tubu*, Tongan
Great	lehibe	libeh (more)	*lahi*, Tongan; *lalahap*, Kissa
Grass	ahitra	—	
Goat	osy	—	
House	trano	—	
High	avo	—	*mow*, Tongan; *bo*, Kayan
Heaven	lanitra	langit	*rangi*, Maori; *langi*, Tongan
Hang	hantona	gantong	*tarona*, Maori
Hole	lava*ka*	lobang	*poka*, Maori; *luoava*, Tongan
Hand	tanana	tangan	
	tangana		
	fandromby		
Husband	vady	swami	
	valy		
Head	loha	ulu	*loha*, *alo*, *lua*, *kulu*, African
	kabosa		
Horns	tandrok	tandok	*tanro*, *tando*, African; *tang*, Thibetan
Horses	soavaly	—	*sowar*, Hindee
Hot	hafana	panas	*umpana*, Amblaw; *bafanat*, Ahtiago; *buhaha*, Sula; *mana*, Kissa
Hundred	zato	ratus	
Hair	volo	bulu	*huru*, Maori; *fulu*, Tongan; *olofolo*, Massaratty; *folo*, Wayapo; *vulu*, African; *pul*, Thibet
	maromanana		
He	izy	dya or iya	*ia*, Maori and Tongan
Iron	vy	*bisi*	*awi*, Amblaw
I	aho	aku	*ahau*, Maori; *au*, Tongan
Island	nosy	—	*nusa*, Javanese and eleven others
Knot	tohy	—	
Kill	vono	buno	
Know	mahafantra	—	
Low	eva	*debawa*	
Life	aina	—	
Lightning	*helatra*	kelat	*uhila*, Tongan
Liver	aty	ati	*ate*, Maori and Tongan
Mocking	eso	—	
Many	maro	—	*waha*, Maori

ENGLISH.	MALAGASI.	MALAY.	——
Mouth	vava	—	*fafa*, Viti ; *bawa*, Bouton ; *suara*, Batumerah ; *fafahi*, Wokan
	mur, mamu	*mulut*	*mlumu*, Kafir (African)
Man	alona	orong	*malona*, Liang and two others ; *kolonan*, Kayan
Male	lahi	laki	
Mother	reny	—	*inai*, Ahtiago ; *inany*, Menado ; *inei*, Kayan
Mind	saina	—	*anga*, Tongan
Money	vola	—	
Net	vovo	—	
Neck	vozona	—	
No	tsia	ta, tida	
Nose	uru, orong	idong	*ihu*, Maori and Tongan ; *uroh*, Bajow ; *oanu*, Bouton ; *irong*, Javanese ; *iru*, Lariki ; *urong*, Kayan
Old	antitra	—	
Passing	lalu	lalu	*alu*, Tongan
Press	terena	—	
Power	zaka	gaga	
Pregnant	vohoka	—	
Pig	lambu	limbu (cow)	*burui*, Sauhili (Africa) ; *burum*, Erob (Torres Strait) ; inverse form of Malagasi term
Rotten	lo	bu*so*	*bopo*, Tongan
Root	faka	akar	*aka-aka*, Maori and Tongan
Rent	hofa	upa	
Rope	tady	tali	
Roof	tafo	*atap*	*ato*, Maori
Road	lalana	jalan	*hala*, Tongan
River	ony	songi	*uve*, Bouton ; *ongagu*, Bolang-hitam
Raise	manangana	menangong (support)	
Rice	vary	padi	*halai*, Cajeli ; *allai*, Batumerah ; *pary*, Kayan
Ripe	masaka	masak	*maoa*, Maori
Raw	manta	manta	*mata*, Maori ; *awta*, Tongan
Silly	gegy	—	
Sheep	ondry	—	
Span	zehy	—	
Small	kely	kitchi	
Sing	*mihi*ra	menyeni	*hihi*, Maori ; *hiva*, Tongan ; *nahinari*, Kissa
Spider	hala	laba	
Swine	kisoa	—	*suar*, Hindee ; *soho*, Tidore
Slave	andevo	—	
Sweet	mamy	manis	*mameko*, Bouton ; *mami*, Tidore ; *may*, Kayan
Strong	mahery	—	*malohi*, Tongan
Speak	mitemy	—	
See	mivarotra	—	*mumata*, Tongan
Sea	rano masina	ayer masing (sea water)	
Spear	lifona	—	*leisanum*, Ahtiago
	saloy, saboa		
Sun	maso andr*o*	mata ari	*ra*, Maori ; *mata alo*, Salayer ; *matin dow*, Kayan
	fanjavabe, maheny		
Shallow	marivo	—	
Sharpen	man*asa*	asa	*oro*, Maori
Sand	fasina	pasir	
Skin	hoditra	kulit	*holit*, Teor ; *kurito*, Bolang-hitam
Tie	fehi	—	

ENGLISH.	MALAGASI.	MALAY.	—
Truth	to	tunto (certain)	
Trees	hazo	—	*rakau*, Maori
Thousand	arivo	saribu	*afe*, Tongan
This	ity	ini	*koini*, Tongan
These	tre*to*	itu (those)	
Thou	hi*ano*	angkau	
Teach	mampianatra	—	
To-day	anio hiany	ini hari	*inaianei*, Maori
Toddy	toaka	tuwak	
Teeth	nif, nifo	—	*niho*, Maori; *nifo*, Tongan; *nifoa*, Matabello; *nifin*, Teor; *nio*, Saparua
Worm	kankana	—	*ngunu*, Maori
	olitra	ulat	
Wink	py	—	
Way	aleha	*ala*man	*ara*, Maori; *hala*, Tongan
Waves	alona	lomba	*gnalu*, Tongan
Work	asa	*gara*	
Write	soratra	surat	
White	fotsy	puti	*boti*, Sula and two others; *umpoti*, Cajeli; *maphuti*, Matabello
Washing	sasa	basa	
Wages	tamby	—	
Weft	tenona	tanun	
Walk	mande*ha*	—	*eva*, Tongan; *malaha*, Kissa
Water	rano	—	*manu*, Bouton; *oira*, Kissa
Woman	vehivavy	—	*wahine*, Maori; *vina*, Ahtiago; *fele lara*, Matabello
	pisafe		
Wise	hendry	—	
Wonderful	mahagaga	maha (great) gaga (mighty)	*maharo*, Maori
Wet	lena	—	
Whisper	bitsikia	bisik	
Wind	rivotra	ribut	
Yams	ovi	ubi	*uwhikaho*, Maori; *ufi*, Tongan; *uwi*, Kissa
Year	taona	taun	*tau*, Maori and Tongan.

Having thus completed the Glossarial branch of the inquiry in as far as materials and space will allow, I now proceed to the second branch, viz., the Idiomatic, and in this I will pursue the same course as in the other, viz., from New Zealand north and westward, making the Malay language the link of comparison, it being the representative one amongst many others at the west end of the Indian Archipelago and best known to Europeans, and consequently best illustrated in literature. First, then, we commence with Maori and Malay, as follows:—

IDIOMATIC COMPARISON.

Maori.

The alphabet is composed of thirteen letters, viz., five vowels, *a*, *e*, *i*, *o*, *u*, and eight consonants—*h*, *k*, *m*, *n*, *p*, *r*, *t*, *w*. The New Zealanders had no literature before the advent of Europeans.

Malay.

When Roman characters are used the alphabet is composed of twenty-one letters, viz., five vowels and eighteen consonants—*i.e.*, counting *h* soft and *h* hard as separate consonants.

A great portion of both languages can be traced to monosyllables and dissyllables, some consisting of the root only, and others of a root and a prefixed syllable.

Maori.	*Malay.*
Adjectives and verbs are modified, both in form and meaning, by the reduplication of one or both of the syllables of the root. An adjective with the first syllable of the root doubled becomes plural, thus *he rakau pai*—a good tree ; *he rakau pai pai*—good trees. It is to be observed, however, that the simple form is used both as singular and plural.	Reduplication of adverbs, nouns, and verbs has an intensitive as well as a multiple effect ; the doubling of an adjective does not pluralise the noun, but the doubling of the noun itself does so, as *sa poko bai*—a good tree ; *poko poko bai*—good trees. Also the simple form without the article prefixed may be singular or plural.
The effect of doubling both syllables of the root is to diminish the intensity of the meaning of the adjective, thus : *mate*—sick ; *mate mate*, sickly.	The effect of doubling the syllables of the root is to intensify the meaning of the adjective, as *sakit*, sick ; *sakit sakit*, very sick.
In the case of verbs, the effect of the two kinds of reduplication is somewhat different. Thus, *kimo* denotes winking of the eyes ; *kikimo*—closed and kept so ; *kimo kimo*, frequent winking.	Here *kejap* signifies to wink ; *kejap kejap*—to wink continuously ; but *tutup mata* signifies to close the eyes.
Nouns and adjectives and verbs may all have a prefix—*whaka* or *wha*—the effect of which is to make a causal verb ; thus *whakatangata* signifies to make a man or treat as a man ; *whakanoho*—to cause to sit ; *whakamohio*—to cause to know.	Here the prefixes *bekan* or *boat* are used in nearly a similar manner, as *bekan betul*—straighten ; *boat gila*—pretend madness.
The usual passive terminations of verbs are *a*, *ia*, *hia*, *kia*, *mia*, *ngia*, *ria*, *tia*, *whia*, *na*, *ina*, and *whina*. Thus *Poro* becomes *porou* *Waru* ,, *waruhia* *Horo* ,, *horomia*	Verbs, active or passive, have properly no inflections, and are expressed as follows :— *Habes* becomes *habes ulih ku* *Chukur* ,, *chukur ulih ku* *Anchor* ,, *anchor ulih nia*
Intransitive, as well as transitive, verbs have a passive voice requiring the addition of a preposition in English to make the sense complete. Thus : *noho*—sit ; *nohia*—be sat upon.	Here the distinctions are made as follows : *bunoh*—to kill ; *ter bunoh*—to be killed ; the passive voice being here rendered by a prefix.
Nouns of circumstance are derived from adjectives, participles, or verbs by the following suffixes :—*Nga*, *anga*, *hanga*, *manga*, *ranga*, *tanga*, *inga*, the choice of termination being somewhat arbitrary. Thus : *Mahi* makes *mahinga* *Noho* ,, *nohoanga* *Titiro* ,, *tirohanga*	Here the same principle is carried out by the suffix *an*. Thus : *Kreja* makes *kreja-an* *Dudu* ,, *dudu-an* *Tingo* ,, *tingo-an*
Numerals have certain prefixes—*e*, *ko*, *toko*, *hoko*, and *taki*.	Numerals have no prefixes.
Passive verbs sometimes have the suffix *tanga*. The force of the same is difficult to determine, sometimes having the same effect as *ana*, thus : *hiko tonu ia ki nga ngarehu*, *apuatanga*—he immediately snatched up the burning coals, and crammed them into his mouth.	Expression by passive verbs is very common in the written language, the preposition *ulih* being used after the verb. Thus: *Arang berniala sabintur de sintak ulih nia dan masokan mulut nia*—burning charcoal was immediately snatched by him, and crammed into his mouth.
The syllable *nge* is sometimes prefixed to personal or possessive pronouns, as *nge-au*, *nge-ona* ; and sometimes it appears as a suffix to the adverbs *pea* and *koa*, thus : *peange*, *koange*, but not affecting the meaning thereof.	Here it does not have an equivalent.
Well-known words may sometimes be met with in such a disguise that it is difficult, at first sight, to recognise them at all.	In the search for camphor the Malays disguise the words by inversion, in order to propitiate the *hautus*, or spirits, whose

Maori.

One of the causes of this is the possibility of trouble arising from the accidental resemblance of the word to the name of some chief. The mere fact of his name, or a word similar to it, being used in a manner considered disrespectful, might be the cause of a quarrel. The following may serve as an illustration of this :—Some years ago the child of a chief of the Ngatiporou tribe received the name of Te Wairama. In consequence of this the word *honu* came into common use for water, and the usual word *(wai)* was avoided for fear of giving offence.

The same word may at different times assume functions of several parts of speech. Thus, nouns are frequently used as adjectives to denote the material of which the thing is made. Thus : *he whare raupo*—a house built of raupo ; *he roto tuna*—a lake in which eels abound.

The accent is on the first syllable as a general rule.

Malay.

assistance they invoke. The word *sungei,* a river, is a term of opprobrium in Jambi, where the word *moara* is used instead. Any Scotchman so unfortunate as to have the name of McIntyre is a great cause of difficulty to the Malays, who will, in well-bred circles, not pronounce his name on any account.

Here we have the same principle, as : *Sa ruma atap*—a house made of thatch ; *lahar ikan mati*—a pool of dead fish.

This obtains in Malay.

SCHEME OF A MAORI VERB.	SCHEME OF A MALAY VERB.
Karanga—call.	*Pangil*—call.

I. Indicative.

1. Inceptive—past or future.

Maori	Malay
Ka karanga ia—he called or began to call ; he will call or will begin to call.	*De pangil nia*—he called or began to call.
Kahore ia e karanga—he began or will begin not to call.	*Mau pangil nia*—he will call or will begin to call.
	Tida pangil pun mulai dya—he began, etc.
	Tida mau pangil pun mulai dya—he will, etc.

2. Imperfect—past, present, or future.

Maori	Malay
He karanga ana ai—he was, is, or will be calling.	*Dya ada pangil*—he is calling.
Kahore ia e karanga ana—he was not, is not, or will not be calling.	*Dya suda ada pangil*—he was, etc.
	Dya nanti pangil—he will, etc.
	Dya tida pangil—he was or is not calling.
	Dya tida nanti pangil, or *Tida nanti de pangil ulih nia* } he will not, etc.

3. Perfect—past, present, or future.

Maori	Malay
Kua karanga ia—he had, has, or will have called.	*Suda ada de pangil*—he had or has, etc.
Kahore ia kia karanga—he had not, has not, or will not have called.	*Nanti suda de pangil*—he will, etc.
	Tida suda de pangil—he had not, etc.
	Tida suda nanti de pangil—he will not, etc.

4. Indefinite past.

Maori	Malay
I karanga ia—he called.	*Dya pangil,* or *pangil ulih nia*—he called.
Kihai ia i karanga—he did not call.	*Tida de pangil ulih nia*—he did not, etc.

5. Indefinite future.

Maori	Malay
E karanga ia—he will call.	*Dya mau pangil*—he will, etc.
E kore ia e karanga—he will not call.	*Dya tida mau pangil*—he will not, etc.

6. Narrative form.

Maori	Malay
Karanga ana ia—he called.	*Dya suda* (or *ada*) *pangil*—he called.

II. Imperative.

Maori	Malay
Karanga—call.	*Pangil*—call.
Kaua e karanga—do not call.	*Jangan pangil*—do not call.

III. Optative.

Maori	Malay
Kia karanga ia—that he should call.	*Sebab de pangil ulih nia*—that he, etc.

IV. Subjunctive.

Maori	Malay
Me e karanga ana ia—If he were calling.	*Kalau ada de pangil*—If he, etc.

V. Infinitive.

Maori	Malay
He karanga—to call.	*Ber-pangil*—to call.

As we have a more extended grammar than the above of the Tongan (or Tonguese), with which the Maori may be considered to be intimately connected, both being dialects of the same Polynesian language that extends from the Samoa group, or Navigator Islands, over the Society, Marquesas, and Sandwich groups, a few comparisons with it will not be inappropriate, seeing that there are some constructive and glossarial differences.

The alphabet consists of seventeen letters, five of which are vowels and twelve of which are consonants, viz., *a, e, i, o, u,* and *b, f, g, h, j, k, l, m, n, s, t, v* respectively. Duplication of words takes place, as in Malay and Maori, under very similar conditions, thus: *toji*, to peck, when doubled *(tojitoji)* means to peck repeatedly; *noko*, the hip, when doubled *(nokonoko)* means a large hip. Of this class of words there are many examples. In other cases no new idea is suggested in connection with the primitive term, as in the above examples; but its meaning is made emphatic or becomes intensified. Thus the word *niji*, vain or vanity, when doubled means the same thing in a strong or superlative sense. There are, however, exceptions to the above rule which need not be entered into here.

There are two classes of articles: (1st) those which precede common nouns—*koe, ae, he*, and the indefinite article *ha*; (2nd) those which are only used before proper nouns, viz., *ko* and *a*.

The masculine and feminine genders are formed by the words *tangata* (male) and *fafine* (female) following the noun, of which there are parallel examples in Malay and Maori.

The plural signs are *gaahi, kau, tunga, faga, otu,* and *fuifui*. The uses of these are various. Our space will allow of only one or two examples by way of comparison.

Tongan.	*Malay.*
Gaue—work.	*Kreja*—work.
Kaugaue—fellow workmen.	*Kaun-kreja*, or *Kaun ber kreja* } fellow workmen.
Mate—death.	*Mati*—death.
Kaumate—dead people.	*Kamatian*—a corpse.

In the declension of nouns there are no inflections, which is also the case in Malay.

Adjectives follow the noun in Tongan, with few exceptions, which also holds good in Malay.

Tongan.

The personal pronouns form a class of words in the Tongan and the Polynesian dialects generally more numerous than in most other languages, and they are always used with peculiar precision. They have also the power of indicating, by different prefixial and terminal particles or letters, the inclusive and exclusive sense in the dual and plural numbers of the first person only.

From the above cause the declensions of these pronouns are more elaborate, of which an example is given below:—

FIRST PERSON.

NOM. *Ko au*—I, or me.
Ko kita—(familiar only)
A au.

GEN. *Ooku*—of, or belonging to me.
Aaku.
Mooku—for me.
Maaku.

DAT. *Kiate au*—to me.
Kia au.
Iate au—in me.
Ia au.

Malay.

The personal pronouns have great variety, and in their uses nicety of meaning, thus:—

FIRST PERSON—*I.*

Aku, *Ku*, *Mu*, *Beta* } used in literature principally.
Saya—used indifferently.
Goh, *Kita* } used vulgarly.
Hamba tuan, *Patek* } used by inferiors in speaking to superiors.

SECOND PERSON—*Thou.*

Angkau, *Kau* } used in literature principally.
Lu—used by superiors in speaking to inferiors.
Inchi, *Che*, *Awa* } used between equals.

It is considered to be rude to use the pronoun when speaking to masters, fathers, grandfathers, mothers, or grandmothers, thus *tuan, pa, to* or *dato, ma* or *ma nenek*

Tongan.	*Malay.*
ABL. *E au*—by me. *Meiate au*—from me. *Meia au.* *Iate au.* *Ia au.*	are used under such circumstances respectively. THIRD PERSON—*He.* *Dya,* before a verb / *Nia,* after a verb } used indifferently. The same sentiment prevails when speaking of masters, fathers, etc. ; and the same rule applies in the third person. By the proper use of the pronouns I have seen the key to the goodwill of the villagers effectually used. By a critical knowledge in these, courtesy, contempt, arrogance, love, candour, dissimulation, etc., can be indicated. The natives have a keen perception of the various shades of meaning.
The form and changes of the verb in Tongan are exceedingly simple. In fact, it may be said that there is but one conjugation for the regular verbs of every description; but the auxiliary signs of the verb vary in the past and future tenses.	This is also the case with Malay verbs.
Euphonic terminations are *a* or *i*, and *ekina, eina, aki, hia, atu,* and *age*; as *oku ou tabu'i koe.* With slight exceptions verbal roots undergo no changes in conjugation; they are destitute of those inflexions which indicate moods, tenses, number, or person. The conjugation of the Tongan verb is therefore accomplished by the use of certain auxiliary signs, particles, and words. Example :	Euphonic terminations occur in *tau, taui*—to know; *ajar, ajari*—to learn; etc. The other principal suffixes are *kan* and *an*, as *boat, boat-kan*—to do. These remarks also apply to Malay, as below :

CONJUGATION OF A REGULAR VERB.

Tongan	Malay
Alu—to go.	*Purgi*—to go.
1. AFFIRMATIVE FORM.	
SINGULAR.	
Oku au alu—I go, or am going.	*Aku ada purgi*—I go, etc.
DUAL.	
Oku ma alu } we two go (exclusive) / *Oku ta alu* } (inclusive)	*Kita dua purgi*—we two, etc.
PLURAL.	
Oku mau alu—we go (ex.) / *Oku tau alu*— (in.)	*Kita purgi*—we go.
2. NEGATIVE FORM.	
SINGULAR.	
Oku ikai teu alu—I go not.	*Aku tida purgi*—I go, etc.
DUAL.	
Oku ikai te ma alu—we two go not.	*Kita dua tida purgi*—we two, etc.
PLURAL.	
Oku ikai te mau alu—we go not.	*Kita tida purgi*—we go, etc.
PAST OR IMPERFECT TENSE.	
SINGULAR.	
Neu alu—I went.	*Aku suda purgi*—I went.
DUAL.	
Naa ma alu—we two went.	*Kita dua suda purgi*—we two went.
PLURAL.	
Naa mau alu—we went.	*Kita suda purgi*—we went.
PERFECT AND PLUPERFECT.	
SINGULAR.	
Kuou alu—I have gone.	*Aku suda ada purgi*—I have, etc.
DUAL.	
Kuo ma alu—we two have gone.	*Kita dua suda ada purgi*—we two, etc.
PLURAL.	
Kuo mau alu—we have gone.	*Kita sudu ada purgi*—we have, etc.

Tongan.		*Malay.*
	FUTURE TENSE.	
	SINGULAR.	
Teu and *keu alu*—I shall or will go.		*Ahu mau purgi*—I shall, etc.
	DUAL.	
Te or *ke ma alu*—we two shall or will go.		*Kita dua mau purgi*—we two, etc.
	PLURAL.	
Te or *ke mau alu*—we shall or will go.		*Kita mau purgi*—we shall, etc.
	IMPERATIVE MOOD.	
	SINGULAR.	
Alu koe—go thou.		*Purgi angkau*—go thou.
	DUAL.	
Alu akimoua—go you two.		*Purgi angkau dua*—go you two.
	PLURAL.	
Alu akimoutolu—go ye.		*Purgi kamu*—go ye.
	INFINITIVE MOOD.	
Alu or *ke alu*—to go.		*Purgi*—to go.

Of adverbs, prepositions, conjunctions, and interjections, no remarks are called for further than that there are some words, or nearly similar words, common to both languages.

General remarks on the above branch will be better left till near the conclusion of this paper. I will therefore proceed to the next step, viz., a consideration of the idioms of the Malagasi and Malayan tongues, as follows :—

IDIOMATIC COMPARISON.

EMPHASIS.

Malagasi.

The emphasis is placed on the penultimate of dissyllables, and on the anti-penultimate of trisyllables and polysyllables, as in—

Voninàhitra—glory.
Fanjàkana—kingdom.

Malay.

The emphasis is placed on the penultimate of dissyllables, as in—

Bàwang—onions.
Ùtan—forest.

But in the case of tri- and poly-syllables, accent varies with the terminations, as in—

Saràwak—Serawàk
Perampùan—woman
Bàgian—gift.
Hàbeskan—finish.

ORTHOGRAPHY.

Having no literature, when Roman letters are used twenty-one suffice, sixteen of which are consonants and five are vowels, viz., *a, b, d, e, f, g, h, i, j, k, l, m, n, o, p, r, s, t, v, y, z.*

Having no known primitive literature, its alphabet is borrowed from the Arabs, composed of thirty-six letters, thirty-two of which are consonants and four of which are vowels; but when the Roman alphabet is used twenty-three letters suffice, eighteen of which are consonants and five of which are vowels, viz., *a, b, t, j, d, r, z, s, f, p, h, k, g, l, m, n, u, o, w, h* (soft), *i, e, y.*

ETYMOLOGY.

A great portion of the roots of both languages can be traced to monosyllables and dissyllables, as—

Lo—corrupt.
Hataka—request.

Buso—rotten.
Mintak—ask.

Roots, in general, are nouns, adjectives, or adverbs. When they are common substantives or adjectives they become verbs by adding a vowel or syllable, or by changing the last syllable, as: *sotro*—drink;

Roots may be nouns, adjectives, or verbs. When the former they become verbs by prefixing a syllable, and sometimes by suffixing a vowel, as: *mula*—beginning; *memula* or *mula-i*—to commence. When the

NOTE.—*y* in the Malagasi vocabulary, when used as a termination to a word, has the same sound as *i* on the Continent of Europe or *e* in English.

Malagasi.

sotroy—let it be drunk; *hanina*—food; *hano*—eat, or let it be eaten.

There are also certain prefixes added to roots of derivative nouns, such as *fi*, *faha*, etc., and suffixes, as *ana*, *na*, *vana*, etc., which affect the initial and ultimate letters of each word, a few examples of which are given below by way of illustration :—

Faoka, *s.* Clearing off
Mamoaka, *v.* To clear off
Fara, *s.* Anything rubbed
Mamara, *v.* To rub or scrape
Farana, *ad.* Level
Mamarana, *v.* To level
Feno, *ad.* Full
Mameno, *v.* To fill
Fody, *s.* Returning home
Mamody, *v.* To return home

Fono, *s.* Shrouded like a corpse
Mamono, *v.* To kill

Fotsy, *ad.* White
Mamotsy, *v.* To Whiten
Hahy, *s.* The dried by fire
Mamahy, *v.* To dry by fire
Hay, *s.* Knowledge
Mahay, *v.* To know
Hantona, *s.* Hanging
Menantona, *v.* To hang

Hariva, *s.* Evening.
Hataka, *s.* A petition
Mangataka, *v.* To beg
Hatona, *s.* Approach
Mamatona, *v.* To approach
Havokavoka, *s.* Beating
Manavokavoka, *v.* To beat
Helatra, *s.* Lightning
Manelatra, *v.* To flash
Heloka, *s.* Iniquity
Manameloka, *v.* To condemn
Hevitra, *s.* Thought
Mihievitra, *v.* To think
Hinaka, *s.* Pomelling
Maninaka, *v.* To beat
Hofa, *s.* Rent
Manofa, *v.* To pay rent
Hombo, *s.* Nail
Manombo, *v.* To cause to grow
Hozona, *s.* Shaking
Manozongozona, *v.* To shake
Kekitra, *s.* A bite
Manekitra, *v.* To bite
Lalo, *s.* A passing by
Mandalo, *v.* To pass by
Lama, *s.* Slipperiness
Mandama, *v.* To lubricate
Lanto, *s.* The act of arranging
Mandanto, *v.* To arrange

Malay.

root is a verb, the word becomes a substantive by a suffix, as: *makan*—to eat; *makanan*—food.

The prefixes to roots are *me*, *men*, *meng*, *pe*, *pel*, *pen*, *ber*, etc.; and the suffixes are *an*, *kan*, *i*, etc., the former of which sometimes affect the initial letters, either by elision or substitution. Thus, *surat*—writing, becomes *meniurat*—to write. Other examples are below :—

Buka, *s.* Clearing off (as of forest)
Membuka, *v.* To clear off
Tara, *s.* A rub
Meniara, *v.* To rub or scrape
Rata, *ad.* Level
Memratakan, *v.* To level
Peno, *ad.* Full
Memeno, *v.* To fill
Mudy, *v.* To go up a stream
Memudy, *v.* Ditto; a common mode of travelling in Malaya

Buno, *v.* To kill
Pembuno, *s.* A murderer
Pembunohan, *s.* An execution
Memuno, *v.* To kill
Iambuno, *s.* The killed
Perbunohan, *s.* A place of execution

Putih, *ad.* White
Memuti, *v.* To whiten
Api, *s.* Fire
Taro de api, *v.* Dry it
Panday, *ad.* Clever. Pandian, *s.* Cleverness
Berpanday, *v.* To be clever
Gantongan, *s.* Act of hanging
Memantong, *v.* To hang; but *gantong* in general use

Hari suda pitang, *s.* Evening
Mintakan, *s.* The act of begging
Memintakan, *v.* To beg
Datangan, *s.* The act of approaching
Menatang, *v.* To approach
Pukulan, *s.* A beating
Memukul, *v.* To beat
Halilintar, *s.* Thunderbolt
Berkilat, *v.* To flash
Chelaka, *s.* Misfortune
Berchelaka, *v.* To cause misfortune
Fikiran, *s.* Thought
Memikir, *v.* To think (*fikir* usually)
Gasa, *s.* A beating
Meniasa, *v.* To beat
Upa, *s.* Hire
Meniupa, *v.* To hire
Tumbo, *s.* A sprout or spike
Menumbo, *v.* To sprout
Goyangan, *s.* Shaking
Bergoyang-goyang, *v.* To shake
Kikiran, *s.* Cut, as with a file
Bukikir, *v.* To file
Lalu-an, *s.* A passing by
Menialu, *v.* To pass by
Lema limbut, *ad.* Softly
Ber-limbutkan, *v.* To smooth
Ator-an, *s.* The act of arranging
Berator, *v.* To arrange

Malagasi.	*Malay.*
Latsa-bato, *s.* Dropping a stone	Lattakan-batu, *s.* Dropping a stone
Mandatsaka, *v.* To drop	Melatta, *v.* To drop
Lavaka, *s.* Hole	Lobang, *s.* A hole
Mandavaka, *v.* To make a hole	Bekan-lobang, *v.* To make a hole
Lemy, *s.* Softness	Lema, *s.* Soft
Malemy, *v.* To be soft	Berlema, *v.* To soften
Loto, *s.* Filth	Kotor, *s.* Filth
Maloto, *v.* To be dirty	Berkotor, *v.* To be dirty
Mandoto, *v.* To make dirty	Meniotor, *v.* To make dirty
Safo, *s.* The act of caressing	Sapu-an, *s.* The act of cleaning with the hand, etc.
Manafo, *v.* To caress	Meniapu, *v.* To clean
Sara, *s.* Hire of a canoe, etc.	Sewa, *s.* Hire of anything
Manara, *v.* To hire	Meniewa, *v.* To hire or rent
Sasa, *s.* The act of washing	Basa, *s.* The washing of one's hands
Manasa, *v.* To wash	Memasa, *v.* To wash
Setra, *s.* Obstruction	Stru, *ad.* Unfriendly
Manetra, *v.* To face opposition	Ber stru, *v.* To be unfriendly
Soratra, *s.* Writing	Suratan, *s.* Writing
Manoratra, *v.* To write	Meniurat, *v,* To write
Tady, *s.* A rope	Taly, *s.* A rope
Manady, *v.* To make rope	Memboat taly, *v.* To make ropes
Taingina, *s.* Act of mounting	Naikan, *s.* The act of mounting
Manaingina, *v.* To raise up	Menaikan, *v.* To get up
Takalo, *s.* Barter	Tukuran, *s.* Barter
Manakalo, *v.* To barter	Ber tukar, *v.* To barter
Tambatra, *s.* Heap	Tambahan, *s.* A heap
Manambatra, *v.* To heap	Menambah, *v.* To heap
Tanty, *s.* A basket	
Mananty, *v.* To endure	Menanti, *v.* To wait
Taranaka, *s.* Generation	Anak anak, *s.* Offspring
Manaranaka, *v.* To produce the same species	Per-anakan, *v.* To beget
Tenona, *s.* Weft	Tanunan, *s.* Weft
Manenona, *v.* To weave	Bertanun, *v.* To weave (usually *tanun* only)
To, *s.* Truth	Tunto, *ad.* Certain
Mankato, *v.* To follow truth	Bekan tunto, *v.* To make certain
Tondro, *s.* Pointer	Tunju-an, *s.* Pointer
Manondro, *v.* To point	Menunju, *v.* To point
Vala, *s.* A small rice field embankment	Batas, *s.* A rice field embankment, or small dam
Mamala, *v.* To partition	Mematas, *v.* To embank
Valy, *s.* An answer	Bali-an, *s.* A return
Mamaly, *v.* To reply	Membalas jawab, *v.* To reply
Vela, *s.* Dung	Berah, *s.* Dung
Mamela, *v.* To leave	{ Memberah, *v.* To stool (usually *berah* only) { Ber-berah
Voa, *s.* Fruit	Bua, *s.* Fruit
Mamoa, *v.* To bear fruit	Ber-bua, *v.* To bear fruit
Vono. See *Fono*	
Zaitra, *s.* Needlework	Jaitan, *s.* Needlework
Manjaitra, *v.* To sew	Menjait, *v.* To sew
Zaka, *s.* Strength	Gaga-an, *s.* The act of applying force
Manjaka, *v.* To rule.	Bergaga, *v.* To strive.

A compound word is formed either by repeating the same, or by uniting others to it, as : *kely*—small ; *kelikely*—rather small ; *sain'olona*—human mind, from *saina*, mind, and *olona*, man.

So, also, we have *kitchi*—small ; *kitchi-kitchi*—very small ; and *s'orong*—one man, from *sa*, one, and *orong*, a man.

The succeeding word in a compound expresses the quality of the preceding, as : *zanaka-lahy*—son or sons, from *zanaka*, child, and *lahy*, male ; *tanan'ankavanana*—right hand.

So, also, we have *anak-laki*—son or sons ; *tangan-kanan*—right hand.

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When there is an elision of a vowel it is specified by an apostrophe, as : *tanan'olona*—human hand ; or otherwise, as in *maso-andro*—sun, from *maso*, eye, and *andro*, day.

There are three definite articles—*i*, *ra*, and *ny* ; *i* and *ra* are prefixed to names of persons to distinguish them from common terms ; *i* is prefixed only to proper names of places. The article *ny* is applied to nouns, and is definite.

Verbal nouns are derived from verbs, and are formed by changing *m* into *mp* and *f*, as : *manoratra*—to write ; *mpanoratra*—writer ; *fanoratra*—mode of writing ; *fanoratana*—things used for writing.

Nouns have three numbers—singular, dual, and plural.

SINGULAR. *Omby iray*—a bullock.

DUAL. *Anabavy*—a brother and sister ; *kambana*—twins ; *izy roa lahy*—the two men.

PLURAL. *Olona maro*—many people ; *omby ireo*—these cattle ; *tranon-tsikia*—our house.

The above are only a very few examples.

GENDER.—The masculine and feminine genders are distinguished by different words, or by adding the words *lahy* and *vavy*—male and female.

Tompokolahy—a lord.
Tompokovavy—a lady.
Lahinomby—a bull.
Ombivavy—a cow.
Zanakalahy—a son.
Zanakavavy—a daughter.

CASE.—The nominative precedes the verb when the agent is the most emphatic word ; but it follows when the opposite, as : *miteny aho*—I speak ; *mitoetra aho*—I stay.

Nouns in the possessive case are expressed as follows : *tanan' olona*—a man's hand ; *tendrok' omby*—a bullock's horn.

Nouns in the objective case are thus placed : *manoraty ny taratsy ny zazalahy*—the boys write the copies.

Malay.

So, also, have we *di'orong*—they, from *dya*, these, and *orong*, men ; again, *mata-hari*—the sun, from *mata*, eye, and *hari*, day.

Definition is effected by the use of the words *di* and *itu*, as : *di orong*—the men ; *itu orong*—these men. There is no indefinite article, but the word *si* is sometimes used in place thereof, as : *si-anu*—a person, or so-and-so.

And here we have *surat* or *meniurat*—to write ; *peniurat*—a writer ; *meniuratan*—mode of writing ; *per-suratan*—things used for writing.

The numbers do not take so elaborate a form, but yet they have exposition, thus :

SINGULAR. *Domba satu*—a sheep.

DUAL. *Ade-brade*—Brother and sister ; *kambari*—twins.

PLURAL. *Orong baniak*—many people ; *domba itu*—these sheep ; *ruma-kita*—our house.

Here we have *laki* and *bini*, as applied to man and wife ; and *jantan* and *betina*, as generally applied to beasts.

Limbu jantan—a bull.
Limbu betina—a cow.
Anak laki—a son.
Anak betina or *perampuan*—a daughter.

The noun both precedes and follows the verb, the latter the more so in the written language, as : *aku kata* or *kata ku*—I speak ; *minanti ku* or *aku minanti*—I wait.

The possessive case takes a similar position, as : *tangan orang*—a man's hand ; *tundok limbu*—a bullock's horn.

Here : *meniuratan turut-i ulih anak laki*—the boys follow the writing.

ADJECTIVES.

An adjective follows the noun when the latter is the most emphatic word, as : *lehilahy hendry*—wise man ; but when the contrary, so the position is altered, as : *hendry ny lehilahy.*

The system is doubtful, both positions being in force, as : *laki bijak*—a man wise ; and *busoh nama*—a bad name. These are transposable by the context.

NUMBERS.

Up to ten have already been described (see Trans. N.Z. Inst., Vol. V.). The teens are differently constructed from the Malay, but twenty, thirty, forty, etc., are precisely similar.

Zato—one hundred.
Arivo—one thousand.

The Malagasi numbers being more similar to those of other races in the Indian Archipelago than to the Malay, one or two examples are here only given.

Sa ratus—one hundred.
Saribu—one thousand.

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Faha roa—the second.
Faha dimy—the fifth.
Faha zato—the hundredth.

Malay.

Ka dua—the second.
Ka lima—the fifth.
Ka ratus—the hundredth.

The possessive pronouns are *ko, nao, ny* —my, thy, his or her; and *nay, ntsikia*, or *tsikia, nareo, ny*, or *njareo* or *jareo*—our, your, their.

After nouns, possessives are *ku, kau*, and *nia*—my, thy, his or her; and *kami, kamu*, and *diorang*—ours, yours, theirs. Before nouns, *punia* is interplaced, as: *aku-punia* —my or mine.

The demonstrative adjectives have various forms, the primary ones of which are given, as under:

SINGULAR.	PLURAL.
Ity—this.	*Irety*—these.
Iroa—that.	*Iretoana*—those.

They precede and follow the words, thus: *ity lamba ity*—this cloth; *ireo zaza ireo*— —these children.

The forms are as follow:

SINGULAR.	PLURAL.
Ini—this.	*Ini*—these.
Itu—that.	*Itu*—those.

The plural being denoted by *baniak* (many) after the words, thus: *ini kain*—this cloth; *ini anak baniak*—these children.

Participial adjectives are derived from verbs: *mividy*—buying; *nividy*—bought; *hividy*—about to buy; *voavidy*—bought.

Membili—buying; *suda bili*—bought; *na bili*—about to buy.

Compound adjectives are formed of two simple words or more with hyphen between, as: *fotsi-volo*—white haired.

Bulu (feather) *putih* (white)—white feathers or down.

Conditional adjectives are formed by adding *koa raha*, as: *tsara koa raha tsara* —better if there be any one good.

Here by adding *kalau ada*, as: *libih baik kalau ada baik*—better if there be any good.

The superlative degree is used when the quality of one thing exceeds that of two or more.

Tsara.	*Tsara noho.*	*Tsara indrindra.*
Good.	Better.	Best.
Ratsy.	*Ratsy kokoa noho.*	*Ratsy indrindra*
Bad.	Worse.	Worst.

Here the form is:
Baik—good. *Libih baik*—better. *Ter libih baik* or *baik sakali*—best.
Korang — bad. *Libih korang* — worse. *Ter libih korang* or *korang sakali*—worst.

The pronominal affixes *ko, nao, ny*—singular; *nay, ntsikia, nareo, ny*, or *njareo*—plural, have the same power and signification, when joined to verbs in the passive voice, with that of the personal pronoun in the nominative case with verbs in the active voice, as: *manoratra aho*—I write; *soratako*—written by me, *i.e.*, I write.

The same forms are used, according to contexts, as: *aku meniurat* or *meniurat aku* —I write; *surat ku* or *surat ulih ku*—written by me.

The relative pronouns are *ileky* or *lehy*—that; *izay*—that which, etc., as: *ny omby izay no vonoiny ny olona*—the bullocks which were killed by the people.

The relative pronouns are *itu*—that; *eiya itu*—that which, etc., as: *limbu itu iang de buno ulih orang.*

Examples of reflective pronouns are as follows: *izaho tena hiany*—I my own self alone; *izaho tena mahafantatra*—I my own self know.

Here: *aku sorong kindiri*—I alone, myself; *aku kindiri mengatau-i*—my own self know.

VERBS.

The verbs in their various phases are so elaborate that salient points can only be noticed. They are simple and reduplicative, as: *mandehandeha*—to walk often about, the simple verb being *mandeha*; *miteny*—to talk; *miteniteny*—to be talkative.

Reduplication also takes place, thus: *ber jalan*—to walk; *ber jalan-jalan*—to be walking continuously; *ber-chakup*—to speak; *ber-chakupchakup*—to hold conversation.

In their moods there are peculiar inflections, according to the terminal consonants,

There are properly no inflections, but incipient indications may be noted in the

NOTE.—*k* and *h* final are not sounded in Malay.

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the list of which is too long to copy and which also are very intricate and artificial, as, in the imperative : *B, ba, be, by* ; *beaza, baza, boa* ; *bao, beazo, boy.* Ex.—To bathe—*mandro, mandroa, androy.*	words : *bermula, bermulai*—to begin ; *ajar, ajari*—to teach ; *tau, taui*—to know ; *lalu, lalui*—to pass.
The auxiliaries consist of *verbs*, as : *efa* —done ; *voa*—shot ; *tafa*—past ; *mahay*—able ; *arelao*—let be. *Adjectives.*—*Tokony* — expedient ; and *mendrikia* — proper. *Adverbs.* — *Aza* — let not ; *aoka*—enough ; *mainkia*—rather ; etc.	The auxiliaries consist of *verbs*, as : *suda* — done ; *ber*—let ; *bri* — give ; etc. *Adjectives.*—*Patut*—expedient ; *baik*—proper ; etc. *Adverbs.*—*Suda*—enough ; *habes* —finished ; etc.

Example.—First Conjugation.

INDICATIVE MOOD —PRESENT TENSE.

Malagasi	Malay
SINGULAR.	SINGULAR.
1st person. *Mampianatra aho*—I teach.	1st person. *Meng-ajar ku* or *aku*—I teach.
2nd person. *Mampianatra hiano* — Thou teachest.	2nd person. *Meng-ajar kau* or *angkau*—Thou teachest.
3rd person. *Mampianatra izy*—He teaches.	3rd person. *Meng-ajar nia* or *dya*—He teaches.
PLURAL.	PLURAL.
1st person. *Mampianatra izahey*—We teach.	1st person. *Meng-ajar kami*—We teach.
2nd person. *Mampianatra hianareo*—You teach.	2nd person. *Meng-ajar kamu*—You teach.
3rd person. *Mampianatra izareo*—They teach.	3rd person. *Meng-ajar diorang*—They teach.

PERFECT.

1. *Nampianatra aho*—I taught.	1. *Ada meng-ajar ku.*

FUTURE.

1. *Hampianatra aho*—I shall or will teach.	1. *Nanti meng-ajar ku.*

PRESENT PERFECT.

1. *Efa mampianatra aho*—I have taught.	1. *Suda meng-ajar ku.*

PLUPERFECT.

1. *Efa nampianatra aho*—I had taught.	1. *Suda ada meng-ajar ku.*

FUTURE PERFECT.

1. *Efa hampianatra aho*—I shall or will have taught.	1. *Suda aku habis ajar.*

EMPHATIC FORM.

1. *Izaho mampianatra*—I teach.	1. *Aku meng-ajar.*

EXCLUSIVE FORM.

1. *Izaho no mampianatra*—It is I that teaches.	1. *Aku lah iang meng-ajar.*

IMPERATIVE MOOD.

1. *Aoka hampianatra aho*—Let me teach.	1. *Berkan meng-ajar ku.*

SUBJUNCTIVE MOOD.

1. *Raha mampianatra aho*—If I teach.	1. *Kalau meng-ajar ku.*

POTENTIAL MOOD.

1. *Mahampianatra aho*—I can teach.	1. *Bulih meng-ajar ku.*

INFINITIVE MOOD.

Present. *Mampianatra*—to teach, or teaching.	Present. *Meng-ajar kan.*

VERBAL NOUNS.

Mpampianatra—a teacher.	*Peng-ajar.*

Second Conjugation.

THE SIMPLE PASSIVE.—INDICATIVE MOOD.

1. *Ampianarina aho*—I am taught.	1. *Ada bel-ajar ku.*

IMPERATIVE MOOD.

1. *Aoka hampianarina aho*—Let me be taught.	1. *Ber-aku bel-ajar.*

SUBJUNCTIVE MOOD.

1. *Raha ampianarina aho*—If I be taught.	1. *Kalau bel-ajar ulih mu.*

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POTENTIAL MOOD.

1. *Ahampianarina aho*—I can be taught.

1. *Bulih aku bel-ajar.*

POTENTATIVE VERB.—PASSIVE VOICE.

SUBJUNCTIVE MOOD.

1. *Raha ahampianarina aho*—If I can be taught.

1. *Kalau aku bulih bel-ajar-i.*

THIRD CONJUGATION.

THE PRONOMINAL ADJUNCTIVE.—INDICATIVE MOOD.

1. *Ampianariko ny ankizy*—the children are taught by me.

1. *Belajarkan anak ulih ku.*

SUBJUNCTIVE MOOD.

1. *Raha ampianariko anareo*—If you be taught by me.

1. *Kalau bel-ajarkan angkau ulih ku.*

IMPERATIVE MOOD.

1. *Aoka hampianariko anareo*—Let you be taught by me.

Ber ajar-kan angkau ulih ku.

POTENTIAL MOOD.

1. *Ahampianariko anareo*—You can be taught by me.

Buli-lah angkau de ajari ulih ku.

ADVERBS.

Of Number.

CARDINAL. *Iray monja*—only one.
ORDINAL. *Indroa*—twice.

CARDINAL. *Satu sejak*—only one.
ORDINAL. *Dua kali*—twice.

Of Time.

Anio—to-day; *anio hiany*—this very day; *miarakaminizay*—instantly; *sahady*—already; *rahateo*—before-hand; *taloha*—before; *omaly*—yesterday; *afak'omaly*—before yesterday; *hiara kaminizay*—immediately; *ampitzo*—to-morrow; *isam bolana*—monthly; *isan-taona*—yearly; *tsia*—no.

Ini hari—to-day; *hari ini*—this very day; *sakarang ini*—instantly; *sadiah*—already; *hadapan*—before-hand; *dehulu*—before; *kalamarin*—yesterday; *kalamarin dehulu*—before yesterday; *sakarang ini*—immediately; *beso*—to-morrow; *ber-bulan*—monthly; *ber-taun*—yearly; *tida*—no.

Of Place.

Ety—here; *tany*—there; *manodidina*—around; *na ato na eny*—whether here or there.

Sini — here; *sana* — there; *koliling*—around; *sini atau sana*—here or there.

Of Quantity.

Be—much; *avokoa*—all.

Be brapa—how much; *samomoa*—all.

Of Quality.

Malakilaky—speedily; *tsia*—no.

Lakas lakas—be very quick; *tida*—no.

Of conjunctions, interjections, and repletives, there are no close affinities between the two languages.

Syntax.

ARTICLES.

The article *I* is prefixed to the names of places, towns, and villages, and also to the names of persons, as: *Iambohipeno*—the village called *Ambohipeno; Ifaralahy*—the name of a man.

The article *Si* is prefixed to villages, as: *Si-rangun*—the village of *Rangun*; and to persons, as: *Si-japar*—the man called *Japar.*

The article *Ra* is only prefixed to the names of persons when they are addressed with respect or with a consideration of superiority, as: *Ra-lahimatoa*—the name of a man *Ramatoa.*

The article *Tun* or *Tuan* is prefixed to the names of Europeans and Arabs by way of special consideration, and as a mark of superiority, as: *Tuan Smith* or *Tun Hajee.*

ADJECTIVES.

The adjective is generally placed after the noun, as: *lehilahy antitra*—an old man. The same adjective precedes and follows the noun, as: *ity lehilahy ity*—this man; *ity vato ity*—this stone; *ireo olona ereo*—these people.

The adjectives follow or precede the nouns according to context, as: *laki laki tua*—an old man; *baik rupa nia*—good appearance. The adjective is not repeated, as: *laki laki itu*—this man; *itu batu*—this stone; *orang itu*—these people.

The pronominal affix of a noun governs the possessive or genitive cases, *i.e.*, the

Here the phrase is *wang orang*, or *wang de orang*—the money of the people; or

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noun that follows it is put in apposition: *volony ny olona*—the people's money, or the money of the people.	*orang punia wang*—the people's own money.
The pronominal affixes that are joined to nouns have the same signification with the English adjective pronouns of the possessive kind.	Here the same rule applies, as below:—
SINGULAR.	SINGULAR.
Tranoko—my house, *i.e.*, house of me.	*Ruma ku*—my house, etc.
Volanao—thy money, *i.e.*, money of thee.	*Wang kau*—thy money, etc.
Ombiny—his cattle, *i.e.*, cattle of him.	*Limbu nia*—his cattle, etc.

VERBS.

One verb governs another in the infinitive mood, as: *mikiasa hanotra aho*—I intended to write.	Here: *handak meniurat ku*—I intend to write.
The transitive passive with the pronominal affixes govern nouns and pronouns in the objective case. *Soatako ny taratasy*—the letter is written by me, *i.e.*, I write the letter.	Here we have this example: *Surat ter surat ulih ku*—the letter is written by me, etc.

ADVERBS.

The adverb qualifies the verb, as: *manoratra tsara izy*—he writes well.	Here: *Meniurat baik dya*—he writes well.

CONJUNCTIONS.

Conjunctions connect words in the following manner: *tany sy lanitra*—earth and heaven; *nandeha izahay fa nitoetra hianareo*—we went away, but you remained.	Here: *Tana** *dan langit*—earth and sky; *pigilah kita tingal-lah angkau*—we went, etc.
The copulative conjunction *dia* connects words that are put in apposition and verbs, as: *Izaho mivavaka aminy Iehovah dia Andriamanitra Tompony ny lanitra sy ny tany*—I worship Jehovah, even God the Lord of heaven and earth.	Here it is: *iya itu*, as, *aku memuji pada Yahowah iya itu Alat Allah iang ada Tuhan de surga dun bumi.* (The terms *langit dan tana*—sky and earth—would not convey the correct idea to the Malay as it seems to do in Malagasi.)

INTERJECTIONS.

Interjections are placed before personal pronouns, as: *lozako re*—woe is me.	Here the expression is: *rosakan saya*—woe is me, or destruction is upon me.
The interrogative repletives *moa* and *va*, are placed before nouns and pronouns, and often verbs and adjectives, as: *tezitra va ny olona?*—are the people angry?	Here the expression is *ka*; thus: *satru-ka di orang?*—are the people at enmity?

Prosody.

The accent is placed on the first of dissyllables, on the second of trisyllables, and on the antipenultimate of polysyllables.

Màro—many.	*Rùma*—a house.
Lèna—wet.	*Bàsa*—wet.
Mandìha—to walk.	*Berjàlan*—to walk.
Mivìdy—to buy.	*Membìly*—to buy.
Mangàtaka—to ask.	*Mengàtakan*—to say.
Mivàrotra—to see.	*Menìngohkan*—to see.

Refraining from remarks on the above till we reach near the conclusion of this paper, I now proceed to the last branch, viz., Phonetic Comparison, commencing with the Maori, as previously done.

PHONETIC COMPARISON.

Vowels are simple sounds properly, and consonants articulations; by the junction of these the illimitable expressions of all languages are recordable.

* In terminations *h* and *k* are used unnecessarily by following the Arab orthography.

But in this branch of the enquiry we have more to do with the mode of creating the sounds and articulations. This is, for the most part, effected by a slightly opened mouth, by the breath, the tongue, and the lips. As the vowels are expressed by the simply opened mouth, they have no other designation; but it is otherwise with the consonants. In the languages under review consonants are divided into labial, sibilant, palatal, dental, aspirate, and compound articulations, viz., dento-labial and dento-palatal, and also, in a small degree, palato-nasal. Neither the intonations of the Chinese, the deep gutturals of the Hindustanee, the rolling vibrations of the Tamil, nor the harsh sibilants of the Arab have existence. Now, it may be surmised that this principle prevails with primitive tribes as it does with single beings in their infancy—that the more primitive or infantile they are the fewer will be their articulations, the less their known wants, the less elaborate their modes of expression. Thus, in the manner that water finds its own level, the first outpourings travelling furthest, so we find in tribes and languages that a parallel exists. I have already stated some cases of this in my former paper, and I need only here allude to the furthest travelled of the Polynesian tribes, viz., the Sandwich Islanders, who have only six consonants in their alphabet. The particular tribes that we now have to do with, have, as regards the Maori, only eight consonants, and as regards the Tongan, only twelve. In observing children of any nation commencing to articulate, it will have been noticed by most of you that labials are first mastered, as in pa and ma; probably next aspirates, and then dentals, then others according to the chapter of happy accidents that make nature's operations so varied and interesting. Thus, in the word "ship," one child may fall on a dental for the first consonant and another on an aspirate; or for the word "food," one may choose a labial, another a palatal. Hence we see a clue to the great variety of articulation of the same word fossilized or preserved in different and distant tribes who have parted in past ages. As an example of this principle I may mention the case of a country-born lady in India, who had never left her native country, telling us that "she was dirty, but her husband was dirty more," meaning that "she was thirty, but her husband was more than thirty." In thus speaking she merely used the articulation and idiom of her native country. So much seems necessary, by way of preface, before we commence at New Zealand, and institute a phonetic comparison between the Maori and Tongan; but before doing so I must also remark on the common transmutation of vowels—many cases may be quoted in our English tongue—but confining our examples to the languages under review, I may state that the Malay of Menangkabau terminates his words with *o*, while the Malay of Malacca does so with *a*, as *sayo*, *saya*. Again, in other dialects, *i* is transmuted into *e*, and *a* into *u*, yet the words so altered may be from one root.

Maori and Tongan.

Each language, or more properly dialect, of the great Polynesian language, has five vowels, but, as stated before, the Maori has only eight consonants, while the Tongan has twelve. Each have two labials, *m* being common to both. Maori has no sibilants, Tongan only one. Maori has only one palatal, Tongan two. Each have only one dental. Maori has two aspirates, Tongan one. Maori has no dento-labials, Tongan two; and Maori has two dento-palatals, Tongan three, as shown below:—

	Labial.	Sibilant.	Palatal.	Dental.	Aspirate.	Dento-labial.	Dento-palatal.
Maori ...	*p, m*	—	*k*	*t*	*h, w*	—	*n, r*
Tongan ...	*b, m*	*s*	*k, g*	*t*	*h*	*f, v*	*j, n, l*

Now, looking at the influence of this selection of their articulations in their respective dialects, we will see the effects on their phonologies in the following words:—

Potiki, a child, in Maori, becomes *bibigi* in Tongan.
Kuri, a dog, in Maori, becomes *guli* in Tongan.
Taringa, the ear, in Maori, becomes *telinga* in Tongan.
Ahi, fire, in Maori, becomes *afi* in Tongan.
Pua, a flower, in Maori, becomes *fua* in Tongan.
Ngaro, a fly, in Maori, becomes *lango* in Tongan.
Wera, hot, in Maori, becomes *vela* in Tongan.
Puaka, a pig, in Maori, becomes *buaka* in Tongan.

and so on. Thus we see how, in a closely allied dialect, divergences commence by the simple, unregulated action of the tongue on different parts of the mouth; also by one tribe having, in process of time or by contact with more highly developed languages, gained and adopted more.

Again, by reducing both dialects to one system of spelling, we find that by taking several sentences of twenty words each, at random, the Maori has 100 vowels for every sixty-three consonants, while the Tongan has 100 vowels for every sixty-two consonants; thus, though differing in the number of consonants in their respective alphabets, they may be said to be nearly equally soft or vocalic in their speech.

Maori and Malay.

Proceeding on the same principle, we come now to compare Maori and Malay phonetically. The Malay alphabet, as stated before, has five vowels and eighteen consonants, *i.e.*, if we allow *h* soft and *h* hard to count as two; but, as I doubt the propriety of this, I may suggest that there should be only seventeen consonants. The *h* soft phonetically really has no existence, and has been adopted by European writers who blindly follow the Arabic system, where the paucity of vowel characters has necessitated the introduction of the final letter "*ha*" to many words actually ending in *a*, *e*, *i*, *o*, or *u*.

It will be seen below that Malay has three labials to the Maori two, two sibilants to the Maori none, two palatals and dentals to the Maori one, three

aspirates to the Maori two, one dento-labial to the Maori none, and four dento-palatals to the Maori two.

	Labial.	Sibilant.	Palatal.	Dental.	Aspirate.	Dento-labial.	Dento-palatal.
Malay ...	*b, p, m*	*s, z*	*k, g*	*d, t*	*h, w, y*	*f*	*j, n, l, r*
Maori ...	*p, m*	—	*k*	*t*	*h, w*	—	*n, r*

The effects of this on the languages will be seen by the following examples :—

Huka, agree, in Maori, becomes *suka* in Malay.
Ahi, fire, in Maori, becomes *api* in Malay.
Hua, fruit, in Maori, becomes *bua* in Malay.
Huruhuru, hair, in Maori, becomes *bulubulu* in Malay.
Kohatu, stone, in Maori, becomes *batu* in Malay.
Mahana, warm, in Maori, becomes *panas* in Malay.
Ngahuru, ten, in Maori, becomes *sapulu* in Malay.
Rima, five, in Maori, becomes *lima* in Malay.
Tohutohu, direct, in Maori, becomes *tuju* in Malay.

and so on. Thus, with a knowledge of the bases of orthography in different languages, one radical may be traced (even though it may assume a different form) to great distances. The cause is seen in the result, so, because the Maoris have no letter *b*, they pronounce *bua* as *hua*, etc., yet the radical, wherever it germinated, was common to both.

Again, by comparing several sentences in each language, we find that in Malay vowels are to consonants as 100 : 122, against 100 : 63 in Maori. This indicates a wide difference in articulation, due no doubt to the approach of the Malay to the consonantal languages of Asia, from whence they borrowed. Hence Malay is phonetically more forcible in expression than the languages of Polynesia.

Malagasi and Malay.

The Malagasi language, as stated before, has five vowels and sixteen consonants. Comparing the latter with Malay, each have three labials, two sibilants, two palatals, and two dentals ; the Malagasi has one aspirate to three in the Malay, two dento-labials for one of Malay, each having four dento-palatals. Thus, their orthography rests on a nearly equal basis, as below :—

	Labial.	Sibilant.	Palatal.	Dental.	Aspirate.	Dento-labial.	Dento-palatal.
Malay ...	*b, p, m*	*s, z*	*k, g*	*d, t*	*h, w, y*	*f*	*j, n, l, r*
Malagasi	*b, p, m*	*s, z*	*k, g*	*d, t*	*h*	*f, v*	*j, n, l, r*

The effects of this will be seen in the phonology, thus :—

Toaka, toddy, in Malagasi, becomes *tuwak* in Malay.
Ova, change, in Malagasi, becomes *ubah* in Malay.
Ovy, yam, in Malagasi, becomes *ubi* in Malay.
Vono, kill, in Malagasi, becomes *buno* in Malay.
Voa, fruit, in Malagasi, becomes *bua* in Malay.
Rivotra, wind, in Malagasi, becomes *ribut* in Malay.

and so on. Hence the same original expressions are clothed in the articulation peculiar to each language, so as to conceal their identity until the principle of their construction is set forth.

Now, comparing several sentences in each language, we find that in Malagasi the vowels are to the consonants as 100 : 92, against 100 : 122 in Malay. Thus, as the consonantal languages of Asia are departed from, the speech becomes more soft and vocalic—a principle which we have seen has had more extended effect in the spread of the cognate tongues easterly, *i.e.*, over Polynesia.

Reverting, then, to the glossarial branch of the subject, in order to fairly weigh the respective affinities of the different races under review, as read by language, I must recall your attention to the fact stated in my former paper as to the relative number of primary words retained by an European language after eight hundred years of disconnection; these amount to only about one twenty-sixth of the whole. Mr. John Crawford, by his investigations, has declared that one fifty-seventh of the Malagasi and one-fiftieth of the Maori dictionaries were Malay, thus proving a connection whose intimacy on European experience can be approximately calculated. But I may venture to remark, from my own enquiries on the same subject, that had the above ethnographer or myself had the advantage of a critical knowledge of both or all languages, instead of only one (the Malay), double the equivalents might be found, and the approaches thus drawn nearer by half. Thus, Crawford states that out of 8,000 Malagasi words he detected only 140 Malayan; while I, out of Griffiths' grammar, containing certainly not more than 500 words, detected eighty, in words that have had preservation throughout the whole region. The effects of peculiar articulation are shown in the following examples:—

English.	Malagasi.	Malay.	Tongan.	Maori.
Fruit	*voa*	*bua*	*pua*	*hua.*
Hair	*volo*	*bulu*	*fulu*	*huru.*

and so forth.

Then, as to idiomatic comparison, it will be seen that Malay, Maori, and Tongan are virtually the same, the divergences in structure being slight. In the declension of nouns, or the conjugations of verbs, there are virtually no inflections. The duplication of words, to weaken or intensify their meanings, are common to the three dialects or languages, and the curious elaboration of the pronouns has more or less existence. The relative position of adverbs, verbs, nouns, and pronouns, in the construction of their sentences, also follows one plan. The parallel is remarkably carried through to Madagascar, excepting in the formation of moods and tenses of verbs, where inflection takes place; and in this respect the Malagasi imitates the Tamil of South India, though their glossaries have no relation to each other. In this latter language, as with Malagasi, the tenses are formed by the aid of certain particles called "words standing in the middle," which are inserted between the root and the pronominal affixes, subject to various changes required by their rules of

grammar. As the pronominal affixes are the same in all tenses, these middle words become the characteristics by which each tense is distinguished. Thus, in this portion of idiom the Malagasi has strong Tamilian affinities, due (if the theory I formerly enunciated be admitted) to the archaic connection with South Hindustan or Barata, and not, in any way, to its more distant connection by relation with Malayo-Polynesia.

In phonetic comparison it will have been noticed that Malay is nearer to Malagasi than to Tongan or Maori, the number of consonants being seventeen to sixteen respectively, the letter *v* being absent in the former, and *w* and *y* in the latter. Yet the Malagasi is much more vocalic than Malay. It may be here stated that there are three dialects spoken in Madagascar—the Ankova, the Betsimisaraka, and Sakalava. The former is by far the most copious, regular, and extensive, and is the only one as yet in which anything has been written or printed. Mr Griffiths characterizes the language as mellifluous and soft, and, equally with the students of Malay in the Indian Archipelago, he panegyrizes it as the Italian of the South. I could never see this, though I have often heard the same sentiment expatiated on. If softness be admirable, then we have it advancing to extreme weakness in the eastern and southern parts of Polynesia, where six to eight consonants are all that are possessed by cognate tribes. Taking Malay as the middle tongue, it is more masculine than the Maori or Tongan, and less vibratory than the Malagasi; thus—

> *Langit*, sky, in Malay, becomes *lanitra* in Malagasi.
> *Kilat*, lightning, in Malay, becomes *helatra* in Malagasi.
> *Kulit*, skin, in Malay, becomes *hoditra* in Malagasi.

Here the Malay expressions have abrupt terminations, while those of the Malagasi vibrate at the end. In this characteristic the phonology of South Hindustan indicates its influence.

Embracing the whole subject then, we have this fact made patent to us: that confined within fifteen degrees of the equator we have one family of languages spreading from Madagascar to New Guinea, and thence easterly to the extremes of Polynesia, New Zealand inclusive; but a breach in which, in this present era, occurs by the breadth of the Indian Ocean. The two portions of the one family situated on the borders of the breach are glossarially and phonetically closer to each other than either of these are to those portions stretching into Polynesia; while, idiomatically, the portion on the west side of the breach—that is Madagascar—shows Tamilian or South Indian affinities. What does this view indicate?

That they all are parts of one original family there can be no question, for when we advance beyond the limit above assigned, as shown before, we meet with Asiatic or Australian nations and tribes, whose languages are of entirely different genius. I have already brought to your notice the

ethnological considerations; these, therefore, should be touched on here as slightly as possible. I will consequently only trouble you in this direction by stating that one author suggests the populating of Madagascar by storm-driven Malay proas; but physical geography is entirely against this theory. Another suggests the sinking of the earth's surface, so that what was once dry land is now the deep ocean; but the teachings of geology forbid this within the period required, for the deltas of the Ganges, Indus, Euphrates, and Zambesi prove that practical quiescence has reigned for these last 100,000 years, while much under that period is abundance for the displacement or movement of races that we have to enquire into.

In primitive races slave-hunting is the first necessity, for by it they obtain ministers to their ease and lust; mercantile adventure follows. Archaic Hindustan, as one of the most prolific nurseries of the human race, would soon have recourse to these great causes of migration and conquest. Lesser ranges than that shown in Plate III. existed in full force up to within very recent times, and yet in a curtailed manner exist, viz., in the Indian Archipelago, whose basis is in Mindanao, and on the east coast of Africa, whose basis is in Yemen. That the Malagasi migration had taken place from archaic India before the age of letters, their want of literature proves; for we may accept it as an axiom that letters once attained to by a race are never lost. Thus two or more small tribes in Sumatra have letters peculiar to themselves, and the small island of Bali, near Java, has preserved for ages not only a Hindu literature, but a dead language—this against the assaults of Mahommedan zeal and Christian power.

Then, if the migration from South Hindustan to Madagascar took place before the age of letters, we have an indication of its antiquity by the cuneiform letters and hieroglyphics of Assyria and Egypt, whose crude attempts at recording words or deeds date not beyond 3,400 years. At that time South India, or Hindustan, would be extending her expeditions east and west, she being the great centre of trade, and, having the necessities, would also at the same time acquire letters of her own, or borrow them from those close neighbours. That her trade expanded, we may judge by the date of the foundation of Tyre by those great East Indian merchants, the Phœnicians, 3,120 years ago; and that the powerful and wealthy partook of or used their merchandize we may judge of by the Song of Solomon, which, 2,900 years ago, celebrated the camphire of Sumatra and the cinnamon of Ceylon, whose chief marts were South India.* Thus the fossil words of Barata were planted westward

* Vasco da Gama, the first direct European trader to India, at the end of the fifteenth century found the stores of Cannanor, Calicut, and Cochin filled with pepper, ginger, nutmegs, cloves, etc., the produce of South India, as well as of Sumatra, Java, the Moluccas, etc. He also found a Hindoo trader on the coast of Africa, as far south as

Basis of conquest & extermination
ARIA
THIBET
BARATA
The most ancient range of Slave hunting and mercantile adventure
NEW GUINEA
Madagascar.
AUSTRALIA
30
60
90
120
150
30
15
0
15
30

in Madagascar over 3,400 years ago. The date of their migration eastward must rest on other grounds than history. That it was very much more remote in past ages than that to Madagascar may be inferred from the incomplete articulations of the Polynesians, who, as the first outpourings, bore away only the first and earlier attempts of a primitive people to express their circumscribed wants in language. When, or at what time, these wonderful people—the Barata—were themselves extruded and obliterated from their original seat by the Thibetan and Arian incursions on Hindustan, we need not now surmise. We may only so far remark that the physiognomy of the modern Malagasi is more Thibetan than Arian.

But, returning to the more immediate object of this paper, it may be truly said that there is no example of a tribe or nation accepting foreign words for their own primary ones. Take, for instance, our own English words for our near relations, the parts of the body, such as head, ears, nose, mouth, etc., or for common objects, such as cow, horse, pig, corn, etc. ; all these Teutonic fossil words are indelibly fixed in our language, notwithstanding all its present high culture and the acceptation of French, Latin, and Greek exotics. So it is with the family of languages or dialects under review. The Maori, Malay, and Malagasi, by their fossil-primary words, prove the common origin of their races, *i.e.*, emanation from one focus of dispersion. Again, philology supports our previous ethnological reasons, not only by the above *data*, but by common idiomatic structure and phonology ; and the Tamilian affinities of the Malagasi, disclosed in this enquiry, add evidence to the theory that that focus was in South Hindustan.

Another circumstance may be mentioned, but I do not give great weight to it, viz. : in races so nearly allied by name—the Malayala of South India, the Malaya of Sumatra, and the Malagasi of Madagascar—having each their seats in the mountains of their respective countries, similar conditions may have promoted the migrations, and similar conditions preserved the remnants.

Thus, had Madagascar not existed, or had it not been populated by its present race, our search for the whence of the Maori, as we proceeded westward, might have stopped at the Silong tribe of Mergui, on the eastern shores of the Bay of Bengal ; but the above circumstances we have set forth force us to proceed across the bay, and point out, as I did in my former paper, that peninsula, fecund of people, viz., South Hindustan, alone commanding all possible eastern or western maritime migrations, as the only possible "*whence*" of the Maori.

Sofola. This, in a measure, indicates the influence of ancient India, and proves her the centre of great movements.

APPENDIX I.

List of Malay words found in Williams' New Zealand Dictionary.

English.	Maori.	Malay.	Remarks.
Fire	ahi	api	
What	aha	apa	
I	ahau	aku	
Resemble	ahuka huka	sarupa rupa	
Warm	ahu*ru*	suh	
To warm	whaka ahu*ru*	bekan suh	*bekan* is a causative auxiliary verb, not much used, of the same signification as *boat* or *ber*, and is the nearest approach to the *whaka* of the Maori
Fibrous root	aka aka	akar akar	
Onwards	ake	akhir	last in time
To-day	aianei	ari ini	
Sickness	*ait*u	sakit *pait*	literally—sick, deadly
Thin roots	aka	akar	
Learn	ako	ajar	
To teach	whaka ako	bekan ajar	literally—make learn
My	aku	aku punia	
Swell on sea	amai	omba	
There	ana	sana	
Here	anei	sini	
Light air	angi	angin	wind generally
Put together	apiti	apit	close
Day time	ao	ari	
Path	ara	aras	direction
Liberal	atamai	ati bai	literally—heart good
Follow	aru	*turut*	
Chase	*aru*aru	alau	
Liver	ate	ati	
Thatch	ato	atap	
Away	a*tu*	sit*u*	thereaway, as pointed by speaker
First	atua	satu	one
Smoke	auahi	awap api	literally—vapour of fire
Eddy	auhoki	*aru*	
River	awa	aier	stream
Valley	awa awa	debawa	below
Pay for	whaka*ea*	bekan be*iar*	literally—make pay
Disgusting	eti eti	tei	filth
Breathe	whaka*ha*	bekan hawa	literally—make breath (not in use)
Come	haere	mari	
Scrape	hakuku	kuku	nails of fingers
Consumed	hama	habes	finished
Oven	hangi	hangat	hot
Thing	h*anga*	bar*ang*	
Encompass	hao	ba*wah*	bring
Pregnant	hapu	amput	copulate
Dance	hari	tari	
Fetid	ha*ruru*	busu	
Wind	hau	hawa	breath
Desire	hia	*saiang*	
Gather	hiapo	impun	
Collect	whaka hiapo	bekan impun	
Tail	hiku	ekor	
Girl	hine	bine	wife
Belly	ho*para*	prut	

Note.—Roots, where necessary, are given in italics, and the Malay words here are spelt independent of Arabic orthography, which is usually and improperly followed.

ENGLISH.	MAORI.	MALAY.	REMARKS.
Feather	hou	bul*u*	
New	hou	bar*u*	
Mud	hu	si*lut*	
Fruit	hua	bua	
Open	huaki	buka	
Hail	huka whatu	ujan batu	literally—rain-stone
Grasping	hui *ropa*	*rapas* ambil	to take forcibly
Trembling	hung*oingoi*	*goiangoi*ang	
Conceal	huna	sim*buni*	
Coarse hair	huru huru	bulu bulu	
He	ia	dia, or eia	
That	ia	ia, or eia	
Fish	ika	ikan	
Nose	ihu	idong	
To-day	inaianei	ari ini	
Drink	inu	m*inum*	
Small	iti	k*itchi*l	
Raft	kahupapa	kayu papan	literally—wood boards
Eat	kai	ma*k*an	
Food	kai	ma*k*anan	
Tree	kai	kaiu	generally wood, but used thus— *poko kaiu*, trees
To eat	kame	makan	inverted, as the *basa cappor*
Call	karanga	p*ang*il	
Old man	karana	katua	the elders
Stone of fruit	kar*ihi*	biji	
Dig for	kari	kori	
All	kat*oa*	sam*ou*	
Shut	kati	*kat*op	
Full-grown	katua	tua	old
Carry	kawe	bawa	
Dig	keri	kori	
Extinguished	keto	katup	closed
Think	ki	p*ikir*	
Evil	kino	hina	
Pronounced bad	whaka hino	bekan hina	seldom used
Thin	kohoi	kurus	or *kurui* in Kedda
Watery	kopu wai	punoh aier	literally—full of water
Full	kopu	*p*unoh	
Not	kore	*k*orang	as in *korang bai*—not good
Old man	karaua	*orong tua*	
Split	kotata	tita	to cleave
North wind	kot*iu*	tiup	to blow with the mouth
To split open	ko*wha*	bla	
Select	kowhiri	pili	
Nip	kuku	kuku	finger nails
Louse	kutu	kutu	
Maggots	kutu kutu	kutu kutu	many lice
Handful	kutanga	sa tangan	
Many	maha	maha	great
Warm	mahana	panas	
Wonder	mi*haro*	heiran	
Dimly	ma*karo*	kabus	
Distant	mamao	jao	
For me	ma*ku*	ku	I, or me
To show respect	mana aki	menaiki	to raise, as with respect
Point	mata mata	mata	
Raw	mata	manta	
Eye	mata	mata	
Wind	matangi	angin	
Be afraid	mataku	takut	
To terrify	whaka mataku	bekan takut	

English.	Maori.	Malay.	Remarks.
Know	matau	tau	
To teach	whaka matau	bekan tau	seldom used
Gape	matata	tita	split
Fountain	mata wai	mata aier	
Filled with tears	mata waia	mata ber aier	literally—eyes watering
Dead	mate	mati	
Put to death	whaka mate	bekan mati	not used
Three	ma*tengi*	tiga	
Parent	matua	tua	old
Nail of finger	mati *kuku*	kuku	
Carry	mau	bau	shoulder
Wonder at	miharo	berheiran	
Desire	minaka	mintak	to beg
Front	mua	muka	
Tie	niko	nika	to marry
Ten	ngahuru	sapulu	
Cry of distress	ngangi	tangis	
Split	nga*tata*	tita	cut
Shake	whaka *oioi*	*bekan goi*ang	
Six	ono	anam	
Make good	whaka pai	bekan bai	
Adorn	whaka pai pai	bekan bai bai	
Good	pai	bai	
Garment	pakikau	pakian	
Fruitful	papua	ber bua	
Cheek	*papa*ringa	pipi	
Flat roofed	paparu	papan	board, or flat as a stone
Crack	pato	pata	broken
Carry	pikau	pikul	
Open	poaha	buka	
Small	pokike	kichi	
Short	poto	si potong	a bit cut off
Stone	pow*hatu*	batu	
Old person	poua	tua	or, *orong tua*
Cut off	pouto	potong	
Flower	pua	bua	fruit
Glow	puhana	ber panas	
Hill	puke	bukit	
Pubes	puke	puke	
Begin to rise	whakapuke	naik bukit	
Rotten wood	pukorukoru	phun buru buru	literally—tree rotten
Handle	puritanga	tangan	hand
Here	raina	sana	
Sky	rangi	langit	
To be raised	rangui	angkat	
Sole of foot	raparapa	tapa	
Cluster	rapoi	rapat	close
Same	rata	rata	as smooth and level
Leaf	rau	daun	
Hundred	rau	*ratus*	
Small	riki	kichi	
In fragments	rikiriki	kichi kichi	
Five	rima	lima	
Two	rua	dua	
Old woman	ru wahine	tua bini	properly *bini tua* (wife old)
Naked	tahanga	terlanjan	
Sea shore	taha tai	tepi tasi	shore of lake
Sea	tai	tasi	lake
Husband	tahu	tua	head of family
Canoe baling place	taingawai	toang-aier	pour water
Slack water	tai mate	tasi mati	not used, but *aier mati* is the phrase

ENGLISH.	MAORI.	MALAY.	REMARKS.
Trample	takahi	takan	to press down
Mat to sleep upon	*taku*pau	tekar	
Root	take	akar	
Sea coast	takut ai	dekat aier	near water
Bury	tanu	tanum	
Assembled	tanga	da*tang*	come
Cry	tangi	tangis	
Loose	tangara	lungar	
Margin	tapa	tepe	
Basket	tapa kuri	timbakul	
Sea shore	tapa tai	tepi tasi	near lake
Thatch	tap*atu*	atap	
Ear	taringa	telinga	
Year	tau	taun	
Light	tau	tau-an	knowledge
Cause to light	whakatau	bekan tau	cause to know
Strange land	tau w*henua*	benua	land
Jeer	tawai	tawa	laugh
White	*tea*	putè	
Here	tenei	sini	
There	tena	sana	
False	tipatipa	tipu	to deceive
Axe	titaha	titahan	an instrument to cut with
Stone	toka	toko bisi	a hammer or iron stone
Thrust	toro	tola	
Push forth	whaka toro	bekan tola	not used
My lady	tua wahine	tua bini	properly *bini tua*—first wife, who is always the highest in rank
Mainland	tua whenua	tua benua	old country—properly *benua tua*
Draw	tuhi	tulis	
Write	tuhi tuhi	tulis tulisan	many writings
Grow	tupu	tubo	body
Growth	tupu	tumbu	
Cause to grow	whakatupu	bekan tumbu	doubtful if used
Deaf	turi	tuli	
Kneel	*tut*uru	lu*tut*	knee
Spy	tu*tei*	in*tei*	to peep
Dung	tutae	tae	
Rain	ua	*u*jan	
Heart of tree	uho	tubo	
Yam	uwhikaho	ubi kaiu	literally—yams of wood, or woody yams; applied in Malay to tapioca
Accuse	whakawa	bekan dawa	
Woman	wahine	bini	wife
Flood	wai puke	aier bukit	water of hills
Manuro	wai rakau	bajau	
Four	wha	a*mpa*t	
Elevate	whata	atas	above
Milk	wai*u*	sus*u*	in Maori the root is *u*, in Malay *su*, the former being composed of two words—*wai* and *u*, *i.e.*, water of pap, the latter, being merely a duplication
Sit	noh*o*	dud*u*	the root is *o*, converted in Malay to *u*. Both words are mere duplications. *d* not being pronounceable in Maori, *n* and *h* have been taken instead
People	h*unga*	or*ung*	the root is *un*, the Maori having the usual suffix, the Malay a prefix

English.	Maori.	Malay.	Remarks.
Age	tau	tua	by transposition of vowels
Argue	*toto*he	*tutur*	to commune. Vowels convertible
Artist	*tohunga*	*tokung*	Malay has no suffix
Heap	ahu	apus	covered
To charge or rush	amo	amo	to charge fiercely with bloody intent
Abundant	nanea	banea	
To collect	puhangaiti	pungut	
To boast	whaka ranga ranga	bekan garang	to simulate boldness
These	enei	anu	
Demigod	atua	antu	spirits
Hail	whatu	batu	literally—stone ; hail in Malay being called *batu ujan*, or stone rain
Country	whenua	benua	
Thirsty	wheinu	na-minum	

On referring to Crawfurd's investigation of this subject, it will be seen that he states (see Trans. N.Z. Inst., Vol. IV., p. 28) that in a Maori dictionary of 5,500 words he found 107 that were Malay, *i.e.* one fifty-first part, or about twenty to the 1,000. In the above list it will be seen that I have detected 235 Malay words in a Maori dictionary containing about 6,000, *i.e.*, one twenty-fifth part, or about thirty-nine words to the 1,000. I have no doubt that a person familiar with both languages, instead of with only one, would detect double the words that I have ; at the same time I must remark that of the 235 words sixteen are compounds, and thus mere repetitions, but this is also greatly the case with the dictionary itself, which goes a long way to swell its volume. The ratio I have given may therefore not be considered unfair.

In as far as I had opportunity to compare the glossaries thoughout, from Madagascar to New Zealand, it is my opinion that Malay is nearer to Malagasi than it is to Maori, and I may venture the suggestion that some of the languages of the Molucca group or of Ceram—such as the Lariki or Ahtiago—will be found very much nearer to Maori than Malay is.

In looking over the above list it should be borne in mind that the articulation of the Maori, as compared with Malay, is imperfect, the former having only the following eight consonants, viz. : *h*, *k*, *m*, *n*, *p*, *r*, *t*, *w*. Thus the greater comprehensiveness or elaboration of the Malay will be found in the following comparison :—

Malay	...	api	aku	akhir	ajar	aras	alau	satu	aier	ikan
Maori	...	ahi	ahau	ake	ako	ara	aru	atua	wai	ika

Malay	...	bulu	idong	*minum*	kitchi	biji	bau	ratus
Maori	...	huru	ihu	inu	iti	ihi	mau	rau

Thus, in most instances, the causes of difference are to be seen in the imperfect articulation in the Maori, or want of the required consonants to give the words the full character, not in any radical divergence of sound.

I have not alluded to the Maorioris of New Zealand in this paper, as I have been unable to obtain a vocabulary of their dialect or language. I would suggest that in the interest of philology this should be obtained from the Chatham Islands, where a remnant of the race yet exists.

APPENDIX II.

Comparative Vocabulary of Maori words (peculiar to the Murihiku dialect, Southland) and dialects of the Malay Archipelago.

ENGLISH.	MAORI (Murihiku Dialect).	MALAY ARCHIPELAGO.
Ant	upokorua	
Belly	puku	*poko*, Galela
Blue	pako	
Boat (canoe)	waka	*waga*, Waiapo, etc.
Body	tina	*ina-wallah*, Saparua
Bow	pakete	*papite*, Salibabo
Butterfly	mo-kara-kara	*kala-bubun*, Mysol
Cat	naki	
Chopper	tuki-tuki	*toko* (hammer), Malay
Come	nou	
Door	roro	*ngora*, Galela
Father	hakoro	*am-akolo*, Teluti
Feather	huru-huru	*huru*, Liang
Fly	rako	*rango*, Bolang-hitam
Husband (companion)	hoa	*koan* (companion), Malay
Island	moutere	
Leaf	rauwha	*ai-rawi*, Lariki
Mat	tiaka	*tikar*, Malay
Mosquito	keroa	
Mother	hakui	
Rat	pouhawaiki	
Root	mure	*ala-muti*, Cajeli
	puhaka	*puhn-akar*, Malay
Sour	mokohi	*a-moki-nimo*, Batumerah
Wing	pakihau	*ni-fako*, Gani
Yellow	whero	*mera* (red), Malay.

The numerals of the Murihiku Maori are distinguished by prefixes, viz., *ko* in the first, and *e* in the rest. This principle is developed in Polynesia and the islands of and near Timorlaut.

NOTE.—The Rev. I. F. H. Wohlers, of Ruapuke Island, Foveaux Straits, was so good as to compare Wallace's 117 words belonging to thirty-three dialects of the Malay Archipelago with the Murihiku Maori, and to send me a list of the same. The above extract of it represents the variations and differences from the North Island dialects as given in Williams' dictionary.

On the Botany of Tahiti.

Communicated by the Hon. W. B. D. Mantell, F.G.S.

Manuscript (Author unknown) found amongst the papers of the late William Swainson, F.R.S.

[*Read before the Wellington Philosophical Society, 12th November*, 1870.]

I have somewhere seen the observation that "the botany of islands is particularly interesting"; this may be the case, but I think it must be construed merely to mean that the study of the plants is interesting, for assuredly in general the plants of isolated islands are in themselves particularly uninteresting, so far as their mere beauty is concerned, and, for myself, I must confess that I always feel a sensation of fatigue at the idea of hunting out the name of a plant which does not recommend itself by beauty, utility, odour, or curiosity of structure. In the botany of Tahiti I do not know of more than three Phænogamous plants peculiar to the island which deserve cultivation for their beauty or utility; the ferns possess many handsome species, but nothing very remarkable, unless it is in one which is spiny, but which I have never seen, and in another (*Angiopteris erecta*) for its enormous size. The Lycopodiaceæ are very numerous and beautiful, like all the tribe, and in some measure make up by their abundance for the paucity of flowering plants; there are on Tahiti and the adjoining island of Morea about sixteen or seventeen species, and perhaps one hundred and sixty of ferns. Of flowering plants I cannot find more than three hundred in all the catalogues put together, and, doubtless, many plants will have been counted twice, or even three times, in this computation, because many plants would be called different names by the different botanists who found them; and, moreover, I have included every common plant (such as *Hibiscus rosa-sinensis*), even although it may be well known by the natives not to be indigenous. The list is also swelled by those common plants which are found on all the tropical islands of each ocean, and which in reality belong to no country in particular, as I see in the list published in the "Ann. Nat. Hist.," by Professor Henslow, of the plants of the Keeling Islands, that all the species common to those islands and Timor are also to be found on the shores of the small islands about Tahiti, except *Acacia farnesiana*; an *Acacia* is found, but it is not *farnesiana*, but an unarmed, downy species, which I have never seen in flower. There is also a much larger species, with leaves resembling those of *lophantha*, but with pods four times as large. *Garlandinea bonduc* is scarce; *Ochrosia parviflora* is not marked as being at Timor, but is abundant here.

The littoral plants found here, in addition to those of the Keelings, are two species *Pandanus*, *Pisonia inermis* and *procera*, one of which was probably the tree which Mr. Darwin saw at the Keelings, and which attains a diameter of five or

six feet, with particularly soft wood. The wood is considerably softer than the lower part of a cabbage stump, but it is nevertheless used by the natives for canoes when they cannot get any better wood. *Paritium tricuspis*, *Ximeria elliptica*, a *Capparis* with angular fruit, *Ipomœa pes-capræ*, and several others. *Convolvulus braziliensis*, *Agati coccinea*, *Erythrina indica*, *Hernandia sonora*, *Morinda citrifolia*, *Suriana maritima*, *Heliotropium aromaticum*, a *Mucuna*, *Sophora tomentosa*, *Canavalia littoralis*, with *Barringtonia speciosa*, very rare. A little further from the sea will in some places be seen a considerable variety of plants, the most conspicuous of which are *Barringtonia*, *Terminalia glabrata* (very rare), *Calophyllum inophyllum* in stony places, *Ficus tinctoria* and *prolixa*, *Spondias dulcis*, and *Inocarpus edulis*, mixed with great quantities of *Hibiscus tiliaceus* and *tricuspis* (*Paritium*), and more rarely *Thespisia populnea* and *Aluerites triloba*. In some districts there are also found in this region whole woods of the Ito, *Casuarina equisetifolia*.

In the more cultivated parts of Tahiti all these plants have been nearly exterminated, and their room is filled by the bread-fruit, cocoa-nut, and orange trees, with an underwood composed entirely of the guava. This plant, which has been introduced within the memory of man, is now the most common plant and the most complete weed in the island. It covers the whole of the low land, and also the hills to the height of about 500 feet, forming a dismal-looking scrub of about ten feet high; above the height of 500 feet it has not yet been able to contend successfully with the thick growth of fern and higher still the native forest, but you see it springing up in every open spot in every part of the island: never was there an instance of a plant so completely taking possession of a country. Four other exotic plants are found among the guavas—*Cassia purpurea*, *Asclepias carassavica* in moist spots, an *Indigofera* with long spikes of copper-coloured very small flowers, and a blue flowered Indian *Crotalaria*, of which I forget the specific name; this last is the only one which accompanies the guava in its excursions up-hill. These four plants form almost all the common weeds of waste places. The weeds of cultivated soils are very few in number, and may likewise have been introduced; the most common are a *Bœhmeria* and a *Phyllanthus*.

After passing the region of guavas the hills are generally entirely covered with *Gleichenia hermanni*, growing on the steep sides so strongly that it is almost impossible to pass through it. Occasionally interspersed are bushes of *Metrosideros villosa*, and, as you get still higher, *M. lucida* (?) in much greater abundance.

At about 800 to 1,000 feet the *Gleichenia* becomes almost lost in the scrub of *Metrosideros lucida*, *Dodonæa viscosa* (?), *Melastoma taitense*, and a species of *Vaccinium* which was called by Bertuo *Arbutus mucronata*. These plants are bound together by two large species of *Lycopodium*, and underneath them are

to be found magnificent specimens of *Schizœa forsteri*. After passing this belt of dry shrubs the numbers of species increase. Often the native forest reaches the crests of the hills, but if it does not the *Gleichenia* becomes mixed up with grasses, *Cyperaceæ*, and other ferns, and *Lycopodiums;* this sort of vegetation continues to the tops of the highest hills that anybody has ever yet ascended —about 3,000 feet; if, however, the hills are moist and covered with wood vast numbers of ferns will be found at the elevation of 1,500 feet, and it is probable that if one could reach the highest peaks (4,500 feet) a still greater number would be found; but I do not expect that there would be a like increase of exogenous plants, because I find the same species of trees very widely dispersed in respect to height after passing the true valley region; but perhaps this might not be the case in the centre of the island, which I have never been able to visit in consequence of the war.

The chief portion of the wood in the upper portions of the hills, in sheltered situations, is composed of *Aleurites triloba*, with interspersed trees of *Weinmannia*, *Carissa grandis* of Bertuo, and one or two *Urticaceæ* and *Euphorbiaceæ*, which I have not seen in flower. The more exposed sides are generally covered with *Rhus apapi* of Bertuo, the largest tree which belongs *exclusively* to these islands; it may sometimes, but rarely, be found 18 inches diameter and 15 feet high. As the *apapi* is a tree which does not give much shade, the ground beneath is generally covered with an under-bush of greater variety than is found in other places, among which the most common are *Alstonia costata*, *Cyrtandra biflora*, and another species much resembling it, *Omalanthus*, sp., *Bradleia*, *Melastoma justense*, *Commersonia echinata*, *Grewia*, and one or two other *Byttrenaceæ*, besides the ubiquitous *Metrosideros lucida* and *Dodonæa viscosa*, the whole bound together by the large species of *Freycinetia*, with its red bracts, *Jasminum didymum*, some *Mucunas*, and two *Alyxias*. These portions of the mountains are undoubtedly the richest in varieties of shrubs; unfortunately they are always so steep that it is next to impossible to explore them. The botanist must confine himself to the mere ridge, where the path runs, which ridge is generally not more than a foot broad; if it should spread out it again becomes covered with fern and ti, or *Dracæna* plants. The extreme ridges of all the hills I have visited have been covered with *Metrosideros*, *Dodonæa*, *Nelitris jambosella*, and *Vaccinium* bushes; on one or two places I have found a *Coprosma*.

Immediately under these sharp crests, with their heads reaching to the level on which grow the more hardy plants, are often to be seen, in tempting but disappointing proximity, many plants which are apparently to be found nowhere else, but which it is impossible to reach, while, at the same time, they are almost within one's grasp. The crests are, as I said, very steep and narrow—in fact, mere walls of earth; they are covered with thick fern and

bushes, so that the abyss on each side is completely hidden from view, and even if it was possible to stick on to a bank of slippery earth, few people would like to try the experiment if they could not see a bottom to arrive at in case they slipped. I am a tolerably good climber myself over rocks or up trees, but I confess that I never could muster courage to descend any of those earth cliffs, particularly after a small experiment which I made one day in climbing *up* a steep earthy ridge about as wide as a horse's back, which experiment resulted in my slipping back about fifty feet, to the great detriment of my nails and breeches in front, and thinking myself exceedingly lucky at last to fall in with a *Metrosideros* bush, which brought me up just at the edge of a still further descent of about 150 feet, where I should not have had the advantage of slipping down astride. After this, when I saw any tempting-looking plants just beneath me, on the crest of a hill, I contented myself with speculating on the probable distance I should have to travel ere I reached the bottom if I over-reached myself, at the same time taking particular care not to do so.

The most common tree to be found in such situations is a large Araliaceous plant, with compressed leaves and about ten consolidated styles, also a plant perhaps of the *Celastroma*, which was procured by my friend M. Vesco, in flower, with tufted entire leaves, like a *Daphne*, and axillary racemes of flowers with an irregular number of lobes and stamens, and apparently a large disk in place of style. I send you a bad specimen of it, which was all I could get.

The common tree-fern of the mountains (a *Cyathea*) is the ugliest I ever saw, and at the same time one of the most curious; it is slender, and quite smooth in the trunk, showing the scars only at considerable intervals, and, apparently in consequence of its great rapidity of growth, the leaves have their bases quite distinct from one another, and more than an inch apart, instead of being, as in all the other species I have seen, quite closely overlapping. It is also curious in throwing out a species of tuberous offset from the upper part of the trunk; these are attached by a small neck to the parent, and in time throw out leaves. I suppose that in time they become too heavy and fall off, making young plants. I hope to send you one or two of them alive to England. There is also a *Cyathea*, very like *C. dealbata* of New Zealand, but it is very rare; it is not proliferous. A slender one, not proliferous, and a very handsome one, with a stout stem, the leaves of which much resemble those of *C. medullaris* of New Zealand; it is sparingly proliferous. I think I have live plants of this also. I do not know of any more species of tree-ferns, but the natives, who call the curious wool of the Sandwich Island tree-fern mamau (mammow), say that the same substance is found, although very rarely, in their own mountains; it is, however, possible that they allude to

the hairs which cover the bases of the leaf-stalks of the large *Cyathea* I have just mentioned, and which resembles the mamau, or puru as it is called in the Sandwich Islands, in colour.

I do not find that any of these are eatable in the young state, like *C. medullaris*, but one of the species of *Angiopteris* produces a curious sort of sheathing process at the base of the fronds, which, when roasted, is very good food for a hungry man—very solid and, I should think, nourishing. The other species of *Angiopteris* I have occasionally seen with leaves fifteen feet long, and a root stock of a nearly spherical shape and two feet in diameter ; it is, without exception, the most enormous fern I ever saw ; the leaves emit an agreeable perfume when bruised or cut. I think there are three species, but am not certain if the one with somewhat digitately-branched leaves, which I have only once seen in the valley of Piré, is different from the eatable one.

I observe in the "Companion to the Bot. Mag." what I think must be an error, although by whom or how made, I cannot at present point out. In the "Specimen of the Botany of New Zealand," under the head of *Gleichenia hermanni*, is appended an observation purporting to be by Forster, which can only apply to the plant which I have always supposed to be *Pteris esculenta*, and which is the common fern of New Zealand, growing everywhere and universally eaten by the natives. I am nearly certain that they do not eat the root of any species of *Gleichenia*, in fact the *Gleichenias* have small, hard, wiry rhizomes. *G. hermanni* is the common fern of Tahiti ; I do not believe the same species grows in New Zealand, and am sure that it is not eaten or eatable in Tahiti. Again, under the head of *Pteris esculenta*, is attached a doubt if it is a native of New Zealand, and it is stated that Forster gathered it at Tahiti. Now, if I am right with regard to the identity of *Pteris esculenta* with the common fern of New Zealand, no such species of *Pteris* grows in Tahiti, nor do the natives of this island eat the rhizome of any *Pteris* whatever—at least I have made every enquiry among the natives, and am also assured that it has not been met with by either one of four very industrious collectors (French officers) who have been in the habit of making botanical excursions for the last two or three years whenever their customary avocations permitted, and I have often heard from them expressions of wonder as to what the *Pteris esculenta* of the catalogue could be. I therefore think that there must have been some changing of labels or mixture of specimens, which has led to a confusion of two very different species of plants.

Among the few eatable plants peculiar to the South Sea Islands, and apparently indigenous in Tahiti, may be mentioned, as deserving the first rank from its utility, the féi (fé-i), *Musa fehi* of Bertuo. This plant in many places covers the mountain sides almost to the exclusion of every other vegetable, and forms a great portion of the food of the natives at all times of the year.

The young plants may be easily distinguished from the banana by their pointed and wrinkled leaves, but the larger ones only by the presence of black patches on the stem, which are not always very apparent, or by cutting it through, when it throws out a great quantity of deep purple juice. The plant when well grown is as large as the largest size banana, and bears a large *upright* scape of *green* flowers, about six under each bract or spathe, which is also green. The fruit, which, even when ripe, is completely hidden by the leaves, is of a dark orange-yellow colour, very closely crowded on the scape, the whole raceme being of a somewhat conical form, from the lower fruit being the largest. The eatable part is of a bright yellow colour, like gamboge, and is hardly eatable in a raw state; not being sweet it is a very good vegetable when cooked; or, when fully ripe, if well baked, it closely resembles baked sweet apples. It has the curious property of colouring the urine of a bright yellowish-green colour, which, however, does not continue; but although the same quantity of the féi may be eaten every day, after about a week the original colour of the secretion will be restored. I am not aware that it has any particular effect on the urinary organs, but the Europeans in general *imagine* that it has. The plant appears difficult to cultivate at the sea level, and I am afraid I shall not succeed in carrying any living ones even to New South Wales. It does not in general bear seed; I have once seen it, but the seeds were abortive. Nevertheless, there is a plant in sparing cultivation at Tahiti which is evidently a hybrid between the féi and the banana, producing an enormous spike of fruit, which takes a *horizontal* direction. From the circumstance of the féi not producing seed, I have been disposed to doubt its being really indigenous to Tahiti; I should like much to know if there are any well-known instances of plants being barren in their true natural locality. An indigenous banana in New Holland produces seed abundantly.

The restrictions on personal liberty imposed by the French authorities at Tahiti, in consequence of the war, are very vexatious. It is necessary to go to the "Ministre des Affaires Européennes" for a permission every time one wishes to go outside the posts, which are, all but one, quite in the town. I had a special permission to pass the more distant post whenever I pleased, in order to go to a garden formed by Capt. Bonard, of the frigate "Uranie," where I had planted a number of my plants. This permission was headed "Permission jusqu 'a nouvel ordre"; nevertheless I was once turned back by the sergeant of the guard, under the pretence that all permissions required to be renewed each month, and mine was dated two months before. I was so well known that I was generally suffered to pass without any interruption. It was very little satisfaction to complain, and have the man reprimanded for his stupidity; and this led me into a rather amusing collision with the sentries at another advanced post. A friend of mine, M. Eugene Vesco, a

young surgeon belonging to the "Uranie," had agreed with me to go on an excursion up the mountain immediately behind Papeite (the settlement), but, in consequence of some rumours of native attacks, the authorities, when he applied the day before for permission, refused to allow him to expose himself. As I was in no danger I received a pass for myself and a native; however, the native was afraid to go, and so I was obliged to go by myself. As the ascent of the mountain would take several hours I set out before daylight, in order to get over the hard work in the cool of the morning, and consequently passed the advanced post for which my permit was granted before the sentries were well able to see me. After passing this post (where I was not asked for my pass), I immediately began my ascent, and the dawn overtook me on the narrow crest of a hill which was in full view of another block-house, distant about a quarter of a mile, but separated by a small valley divided into two by a small hill rising in the middle of it. When the sentries first discovered me I was just on the top of the first ascent, and at the commencement of a long, nearly level, crest, about five feet wide, which led towards the higher hills, but in a direction nearly parallel with the crest or range on which the block-house was placed. I had gone on perhaps two hundred yards, when I noticed somebody calling; I had heard it before, but never thought it was for me. I looked round, and saw a great commotion among the soldiers, five or six of whom had run down the side of their hill, and were in the first little valley. However, seeing that I stopped, one of them called out to me to know where I was going. I told him, and that I had a permission, which I took out and held up for him to see; this did not satisfy him, and he said I must come down and show it. I told him that I had passed the post in the valley of St. Emilie, and that I would not take the trouble to go so far out of my way as to go to him, but that I would wait for him if he chose to come to me. "If you don't come we'll fire"—muskets pointed accordingly; but as I was determined not to undergo the detention and unnecessary fatigue of climbing up and down three steep hills merely to gratify the curiosity of a French soldier, I merely said—"tirez si vous voulez," and jumping off the crest on to the slope was out of their sight in an instant. Not exactly liking to trust the "tigre-singe," in case they should pursue me, I made the best of my way along the side of the hill, well knowing that by the time they arrived at the place where they saw me I should have quadrupled my distance from them, because I was progressing along a nearly level line, while they were climbing two very steep hills; and I was quite right in my calculation. When I came to the end of the ridge, and in order to continue my ascent was obliged to show myself, I saw that only one had reached the path where I had been, and at the distance which I had reached I did not much fear his one musket, especially as I knew that he must be tolerably out of breath with his exertions.

I sat down on a stone and knocked the dirt out of my shoes, just to vex him, and in five minutes more was in a place where I knew very well he would not dare venture to pursue me.

The tops of these first ranges of hills are frequently quite bare of vegetation, apparently owing to some poisonous ingredient in the soil, which is of a bright red colour, like ochre; when anything does grow on these red patches, which are always very much cut up by watercourses, it is the *Metrosideros villosa*, which clings to any small portion of brown soil that may have been brought down from a higher level by the rains, and makes a miserable sort of living in the midst of desolation. Where the soil is not red it is covered, in patches only, with a few dry grasses, particularly a *Cenchrus*, *Bidens australis*, stunted grasses, and *Gleichenia*. After passing these barren spots I came to a path along the side of a hill, which was more fertile, and was covered with other grasses, a pretty *Hedysarum* with purplish flowers, stray *Diosmeas* and *Tamuses*, also a large plant which I never saw anywhere else, and which appeared to be a *Smilax*, but it was not in flower. Several species of *Cucurbitaceæ* and *Convolvulaceæ* grow among the grass, and also several ferns worth collecting.

At the bottom of this slope, just where the path entered the bushy fringe of the little stream, is a tree of a species of *Pittosporum*, with insignificant greenish flowers, rare in most parts of Tahiti, but not uncommon in Morea; in general appearance, when in fruit, it strongly resembles *P. undulatum*. The path crosses the stream just above a pretty little cascade, overshadowed by a clump of bamboos, which grow from near the bottom; on the other side, in a sort of niche, is a plant of the féi. There are two little basins of rock through which the water passes before it falls, and it is altogether a charming place for a pic-nic. I have once or twice made my breakfast there before going further; as it is the last water on the road it is necessary to fill your bottles here for the day's supply. I intended to have made this spot a sort of wild garden, but had only time to plant one tree, a *Bixa oullana*, which some future botanist will perhaps wonder at finding in such a spot. On the burau and pirita trees here (*Hibiscus tiliaceus* and *Nauclea nitida*) are to be seen four or five kinds of orchideous epiphytes (*Dendrobium biflorum* and *D. myosurus*), the plant called *Cyontidium umbellatum*, and the two orchids so common on the small islands of the group, one with equitant leaves, and the other without any leaves at all, but merely a mass of green roots with a little scape of almost invisible flowers; I suppose them to be the plants called *Epidendrum fasciolata* and *equitans* in the catalogues, because formerly every plant which was not a *Dendrobium* was an *Epidendrum*, and *vice versâ*.

It is no use to ascend this valley; I came down it once, and got nothing for my trouble but torn clothes. On crossing this little stream I passed under

an orange tree, and found a path leading up the face of the hill. On reaching the top I found that the crest was not over a foot wide in many places, and that on the other side was a little valley, a tributary of the Vallée de la Reine, full, apparently, of bamboos, and therefore not inviting a descent. Along the crest is to be found abundance of a curious little *Ophioglossum* about an inch high in the larger specimens; also good specimens of the universal *Vandellia crustacea.* About half a mile further up the ridge, the valley to the right begins to show some variety of vegetation; there are several fine trees of pua (*Carissa grandis*, But.), *Weinmannias*, *Rhus apapi*, and one species of *Cyrtandra* with large flowers and small leaves, which is, perhaps, different from the common ones found further up the mountain. There are also several good ferns to be found here. About a mile further on the path led alongside of a precipice, which forms one of the sides of the deep Vallée de la Reine, bare of vegetation in consequence of fires. Here are those large rambling *Lycopodiums* in great abundance, a curious Restiaceous (?) plant with leaves so exactly like those of an *Iris* that before I saw the fruit I thought it must be a *Libulia*, several *Carices*, two or three species or varieties of *Metrosideros lucida*, two species or varieties of *Vaccinium*, *Arthropodium* sp., erroneously called *cirrhatum* (a very rare plant), and *Schizæa forsteri*, and many other plants. Along the side of the valley he will see *Commersonia echinata*, *Grewia mallococca*, and perhaps one or two other plants resembling them, *Aplonia costata*, and many other trees. On the opposite side of the valley, to the left, near the highest point of the range, I found the only specimen I have seen of a Euphorbiaceous tree, with cordate downy leaves, and the female flowers strongly resembling *Stillingia.*

Following on the side of the precipice, I came at last to the commencement of the bushy top of the mountain. Just before I entered the wood I found, on a tree of *Dodonæa viscosa*, two orchids, which I have never seen anywhere else, and, which, I believe, nobody else has ever succeeded in finding. At the time I discovered it the tree was quite covered with the plants. They are two of the smallest orchideous epiphytes I ever saw; the most abundant consisted of a green root only, of a triangular or doubly-keeled shape, running along and closely adhering to the bark, just in the way of the roots of *Gunnia;* the flowers were very small and inconspicuous. The other had leaves like a *Gamya*, but the flowers were almost invisible, and the scape was covered with very large foliaceous bracts. As I fortunately preserved the only two flowering plants in spirit, you will be able to determine the genera from the specimens.

I had now entered the damp bush surrounding the top of the mountain—the richest locality for plants that I know of in Tahiti—and every step added something new or rare to my collection. Here are to be found together

all four species of *Cyathea*, the commonest being the large hairy species, one of the handsomest I know, *Ophioglossum* sp., and *O. pendulum*, an excessively rare plant,* two or three *Acrostichums*, a *Botrychium*, two beautiful epiphytal *Lycopodiums*, and a most exquisite terrestrial flat-branched species resembling a fern in appearance, two species of *Angiopteris*, the gigantic sweet-scented species, nai or nahi of the natives, of which there is here the largest specimen I ever saw, with leaves fifteen feet long, and the smaller eatable species, or pura (purra), which the natives tell me is only found in three places in the island. I observe that they are very difficult to distinguish in the dry state; when alive they are easily distinguished by the leaflets of the pura being somewhat crumpled or bullate, while those of *A. erecta* are longer and quite flat. Here, too, is the prickly fern found by M. Vesco, but overlooked by me; in fact, the wood is full of rare ferns, both terrestrial and epiphytal. Here I found a plant which I should feel certain was a *Commelina* if I had not been before deceived with what I afterwards found to be an orchid. I have never been able to find it in flower, but have live plants doing well. I have also found an *Astelia*, but forgot to pick up the specimen which I tore down from the tree which I had ascended for the purpose.

Passing the wood I began to ascend a steep wall of earth which forms the extreme summit of the range, finding on the ascent a plant of the *Restiaceæ*, with leaves like a *Marica* five feet long, and, at the top, the *Coprosma* (which, however, I need not have gone so high for), and the plant I have previously mentioned as possibly one of the *Celastraceæ*, and which has, hitherto, been only found in this place. There is almost as great a variety among the trees and shrubs as among the ferns, but I do not recollect more than two or three peculiar to this locality; one is an Urticaceous tree with spikes of fruit resembling a *Piper;* another, a very large-leaved *Cyrtandra*, making the fifth species in Tahiti. Four species may be found at this spot: two of them slender, twiggy shrubs, and the other two strong, upright-growing plants, with leaves a foot long, and huge heads of sweet-scented white flowers, as large as *Achimenes grandiflora;* one species is very common in all damp situations inland, whether mountain or valley; it has thin wrinkled leaves; the species which I have only seen here has equally large leaves, but they are fleshy, smooth, and white underneath. It is a strange thing that I have never but once found a fruit on the common kind, although all the others ripen and seed abundantly. In the common sort the peduncles are very short, and the immature seed vessels appear always to be destroyed by the rotting of the great fleshy mass of decaying bracts and calices surrounding them. They would

* It was discovered by my friend M. Vesco that the sporules of *Ophioglossum* are inflammable, like those of *Lycopodium*, which they exactly resemble in appearance. Is this generally known?

be superb plants in a stove, and I hope I may succeed in sending them alive to England, as this is the only way by which you will be able to see them, it being quite impossible to dry specimens; they *will* rot in spite of anything that can be done. I am very sorry I never thought of taking some bottles of spirit up the mountains with me to put them in, or of writing descriptions of them on the spot. There is also growing here another very large-leaved plant, which I at first took for another *Cyrtandra;* it, however, turned out to be a Cinchoniaceous plant, with enormous deciduous stipules and thick downy flowers three inches long, which I never found but once.

One great disadvantage of going alone on these expeditions was that I could not carry any paper with me, and by the time I returned to Papeite the greater portion of my large specimens of ferns was spoiled by the heat, or by having been crammed too hard into my tin box; and as I had but very little time to spare, and it was very difficult to get any person to do anything out of the ordinary way, I never could manage to find time to make any kind of straps for carrying a portfolio on my shoulders, and it would have been quite beyond my powers to have carried it any other way up the Tahitian mountains.

In coming back I lost my way, in consequence of overlooking the proper place for descending from the main ridge to the watering place I have spoken of. I found out my error in time to have rectified it if I had pleased, but knowing that I was on a ridge which must lead down to the Vallée de la Reine, which I was perfectly acquainted with, I thought I would try if it might not be an easier road than the one by which I came. I had, however, abundant occasion to repent of my temerity, for when I arrived at the end of the high part of the ridge, and had descended a long slope of earth which it was impossible to think of climbing again, I found myself cut off from the valley by a precipice, which I was obliged to skirt for about a mile, through long grass which cut my face and hands, and bind-weeds which constantly tripped me up, over logs and stones, momentarily in danger of falling over the face of the cliff, which, after all, was only about 50 feet high. I at length found a break in the rock through which I managed to slip, and the rest of the way down to the valley, although it was over loose stones over which I was obliged to make my way in a sitting posture for fear of falling, was comparatively easy. If it had not been raining a deluge the whole time not one of my specimens would have been worth anything by the time I got to Papeite; they would have been dry; as it was they were terribly bruised and torn, and, of course, many lost. Another time I lost my whole day's work through missing my way in a valley at the commencement of my journey in the dark, and trying to recover myself by climbing the side of a hill covered with fern (*Gleichenia*), which turned out to be so strong and high that, although I had not above

half a mile to go before I got to the top, where it was reasonably good walking, I was fairly tired out before I reached any place where I could expect to find any plants worth collecting.

Another time I will give you an account of a journey I made to the camp of the "enemy," or insurgents, as the French call the independent Tahitians.

Fataua is the name of a valley through which a stream runs that passes within a mile of Papeite, and which was, before the war, the chief bathing-place of the inhabitants. The stream, like most of the others in Tahiti, appears to increase in size as you ascend it, so that at the first crossing place, about four miles from the sea, it appears almost worthy of the name of river, which no one would think of applying to it lower down. In or about six miles after entering the valley there is nothing to be found in it worthy of looking after, it being a dry open valley, and consequently full of guava trees which always exclude all the indigenous vegetation. After crossing the stream about sixteen times you arrive at a division of it into two nearly equal parts. I once followed up the left-hand branch, but found my progress stopped after going about two miles, by the narrowing of the valley, and by the chasm through which the stream flowed being choked up by rocks; the vegetation, too, consisted of *Scitamineæ* and féis, the neighbourhood of which is always a very good harvest ground for the conchologist, but very bad for the botanist.

The right-hand stream appears at the first to be smaller than the other, but if followed for about half a mile it again branches into two; this time the left-hand one is decidedly the largest, and, in fact, it is the main stream of Fataua. If it could be followed for about a mile I have no doubt but that a rich harvest of mosses, etc., might be collected from the rocks at the bottom of the cascade, where it falls about 250 feet clear into the centre of a large amphitheatre of perpendicular rocks. This fall I have only seen from above, and I do not know if anybody has ever visited the lower part, or whether it is possible so to do. The scenery—with the mountains sloping down on each side towards the great cavern into which the stream appears to be engulfed—is magnificent in the extreme. Instead of following either stream, I one day mounted the ridge dividing the two lower ones, and, after a little search, found a well-beaten path, which, after following about two miles, brought me in sight of the chief pa, or fort of the natives, which consists of a mud wall with embrasures crossing the valley on the top of a small lateral ridge, just above the waterfall, and facing the shelving precipice along which leads the path by which every one who wishes to enter the upper valley must approach. As the wall of rock below is quite perpendicular for a considerable distance, and the mountains above almost too steep for anything even to grow upon, and, moreover, composed of a soft crumbly sort of greywacke, which is always coated

with a thin covering of greasy soil; this fort may reasonably be considered as impregnable, in fact ten men might defend it against ten thousand. Nothing here so much convinced me of the cowardice of the Tahitians as seeing this place, and knowing that when the French marched to attack it, they not only advanced to within two hundred yards of it, but that when they got there the natives who were in the fort ran away after firing one or two muskets; fortunately, or unfortunately, the French received orders to return just at the same time, and never knew that the defence was abandoned. As I had this account from the natives themselves at the spot, there can hardly be any doubt of its truth. When I asked them why they did not stay in the fort and kill every Frenchman who attempted to cross the narrow path, they said that there were very few men in the fort, and they were so astonished at the hardihood of the soldiers in coming so far that they never thought of fighting, but threw away their muskets and ran up the mountains as fast as they could. The cowardice and imbecility of the defenders (!!!) of this valley can hardly be understood by a person who does not know the country, but you may have some idea of it when I tell you that the valley must be as narrow and more difficult than the Kyber Pass, with the additional advantage to the defenders of the sides of the mountains being covered with trees, which would effectually shelter them from the fire of the attacking party, and that of 800 soldiers who marched up it, only about forty altogether were killed and wounded. Who can feel any interest in such a pack of cowards? Had they been any other people in the world than Tahitians there can be no doubt that not a Frenchman would have returned alive to tell the tale.

On the road to the pa I found a tree in flower, with handsome leaves growing at the ends of the branches, like a *Terminalia*, and with a vast profusion of flowers growing out of the trunk and root as well as the branches; these flowers were hexandrous, and appeared to resemble those of *Laurinæ*, but the fruit was just like that of *Ægiurus*; the leaves of this were lanceolate and simple, but M. Vesco tells me that he found, at Borabora, another tree with the same flowers and mode of inflorescence, of which the leaves were digitate, like *Caroliniæ*.

Before I had left the stream I saw some way up the mountain what appeared to be a tree with red flowers, but as I had never heard of such a thing in the island I was obliged to content myself (as I could not approach it) with thinking that it might only be the stipules of *Nauclea*. However, just before I came to the foot I saw, almost ten feet below me, another plant, which I immediately recognized to be the same, and to be an *Erythrina*, which I take it is quite new, unless it should be the one attributed to the Sandwich Islands under the name of *Monosperma*. When I arrived at the narrow path it was nearly dark, but I could see a great commotion in the pa; however, I walked

on without taking any notice until I was close enough to hear what they said, when I found that that they had immediately recognized me for a Piritani, or Englishman, and that I was quite welcome. My attendant, a long Yankee of full six feet, presently made his appearance, having lagged behind because he considered it the most prudent course to keep his precious person out of sight until he discovered how I was received. I soon recognized two or three women as old acquaintances, and through their good report was soon made quite at home in the house of the chief, which, not being a large one, was given up to me for a sleeping apartment. After making a good tea with the things I had brought with me, I had a long talk with the natives about the war, and elicited the information I have given you above. Next morning, at six o'clock, I started up the valley, by which I hoped to reach the summit of the high triangular peak of the Crown mountain, as it is called, which is nearly as high as any point in the island.

The valley widened out considerably more after leaving the pa, but as the greater portion had been in cultivation or was covered with féi trees, I did not find much. I found, however, one rock covered with a plant I had previously only seen in the valley of Piré, and which I had then taken for one of the *Commelineæ;* it was here in flower, and turned out to be orchideous, but very insignificant. It had round, upright, fleshy stems and pointed oval somewhat serrated leaves, so that I think I might be excused the mistake. The first new plants I saw were on a small ridge which we crossed in order to avoid a long bend of the stream; I here found *Alyxia stellata*, *Nelitris jambosella*, and the *Arthropodium* for the first time, besides one or two *Myrtaceæ* not in flower. About a mile further on I saw a very handsome downy-leaved *Metrosideros* growing out of a rock in the middle of the stream, and on a hill, which I ascended by mistake, I found two species of a curious tree with jointed branches, like a pepper, opposite oval serrated leaves and long lax racemes of small, blackish fruit. This is not an uncommon plant, but I have never seen it in flower. On the side of this hill I saw great numbers of my new *Erythrina* in full flower, but only one within reach. They varied in colour from almost white to scarlet, and unfortunately the one I was able to get at was a pale flesh-coloured one; it was entirely without prickles, and had a very downy calyx, and fruit which appeared to be monospermous, but were too young to be certain of. The trees were entirely naked, but some twigs which I brought with me have grown in my plant cases, so that I shall be able to describe it from cultivated specimens. This was the very last plant I found of any interest. I continued on up the valley until about two o'clock without finding anything more. At the point where I turned I passed a tree quite covered with a sweet-scented orchideous epiphyte, which I had not seen before, except in one spot, and *Lobelia arborea* was very common; but

although this would have been very interesting to my French friends, it was not so to me, as it had happened, curiously enough, that I had never gone out by myself without finding it, and they only knew it from my specimens, having never been able to meet with it, even when I directed them to the spot where I had gathered it. It is a curious enough plant from its true arborescent habit, but the flowers are not handsome, being dark green, stained on the lip with purple; they are somewhat remarkable for their coriaceous texture and for being sweet-scented, a character I do not recollect among *Lobeliaceæ*. There is a closely allied species at the island of Raiatea, which is much regarded by the natives, who consider it in some manner as sacred to the Queen. It is, I believe, very rare. The flower is white, but otherwise just like the other, save that I do not hear that it is "noa-noa" (sweet-scented); the stems appear very succulent, and the leaves are lanceolate, finely serrated, and very much crowded on the ends of the branches. The native name is "tiari apatai"; "tiari" means a flower, or more particularly the flower of the *Gardenia;* I never could discover the meaning of the second word. I promised a woman who was going to Raiatea a new handkerchief if she would bring me up seeds or a plant of it, but she did not return before I left. I also promised a sister of the Queen's to give her a plant of the double *Gardenia,* of which I was the sole possessor, and which is so much coveted that I might have got for it almost anything I had chose to ask. I left the *Gardenia* with a friend who will give her the plant and forward the seed to me when she gets it, which, through her sister, she will no doubt be able to do.

I found that it would take, as the natives had told me at the pa, a whole day at least to get to the top of the Crown, and I therefore was obliged to give up the attempt for the time, fully intending to return some other day when I had more time at my disposal, but just when I was thinking of again making the attempt I received a message from the natives to request me not to come, because the natives at Punaria, another stronghold at the other end of the pass, were jealous of my having been there. I should still have made the attempt before I left the island if I had not been attacked with an illness which made me fear the effects of walking so much in the water, as I should have been obliged to do in ascending the valley.

Abstract of Lecture on New Guinea. By Captain MORESBY, R.N., of H.M.S. "Basilisk."

[*Read before the New Zealand Institute, 20th September,* 1873.]

THE lecturer first pointed out that though New Guinea had been discovered prior to any other island in the Australasian seas—no less than 347 years ago —yet it still remained almost the only *terra incognita* of the inhabited world, and said he should show geographical features and national characteristics wholly at variance with all preconceived opinions of the shores and people of that great island. He then gave an historical sketch of the different visits made to New Guinea from the year 1526 to the present time, including an outline of the encroachments of the Dutch on the western shores, and illustrated, by an account of the cruel massacre of the crew of the German schooner Franz in last March by the natives under the Dutch rule, how little that nation had done to civilize the western races of New Guinea. Before describing the cruise of the "Basilisk," the lecturer called attention to the fact that two distinct races inhabit the southern shores of New Guinea—the black Papuans and the light-coloured Malay race. The former occupy the low, swampy, malarious coast from the head of the Gulf of Papua for nearly 1,000 miles to the west. They are perfect savages, the males going entirely naked, and are only elevated above the degraded Australian natives in having fixed homes and in slightly cultivating the land. The latter occupy the southern shores from the head of the same gulf to the extreme east, and are much higher in the scale of civilization, being all decently clothed, good agriculturists, and well acquainted with the art of rude pottery.

The "Basilisk" left Sydney in December, 1872, for the purpose of suppressing the illegal practices against the Polynesians on the pearl shell and *bêche-de-mer* fisheries in Torres Strait. Having made prizes of several vessels which had taken natives from the Polynesian Islands without a license, she proceeded to the S.E. coast of New Guinea, the first point touched at being Yule Island. Between Yule Island and Hood Point—120 miles—the whole of the coast line was laid down by Captain Stanley, of H.M.S. "Rattlesnake," in 1849; but the only point landed on was Redscar Bay, where, after a very brief intercourse with the natives, hostilities were anticipated, and the party at once returned to the ship.

When about twenty-five miles E.N.E. of Yule Island, the "Basilisk" found herself, at daylight, off a vast extent of drift-wood and uprooted trees of great size. They were first reported as reefs, causing considerable anxiety until daylight revealed their real nature. This led them to suppose that inside Yule Island they would find a large river which might prove a road to

the interior of New Guinea. Yule Island lies off the entrance to a large, well-sheltered sheet of water, now named Robert Hall Sound, where the "Basilisk" remained several days. The island is about 550 feet in height, well cultivated, and fertile. The mainland, excepting some bold headlands, is one vast extent of flat swampy-ground, extending six or eight miles inland to a low range of hills, which are backed up by range after range until they culminate in the magnificent Owen Stanley Mountains, 12,000 to 13,000 feet high. They were not successful in finding a river leading to these high lands. One river, which looked capacious enough to raise their hopes greatly, proved, after its sluggish course had been followed for many miles, to lead nowhere, and to be merely the drainage of the immense surrounding fresh-water swamps. A rapid river emptied itself into that just referred to, but its current was too powerful to admit of the captain's six-oared galley ascending its course far. It was from this latter river probably that the drift-wood seen at sea was derived. The scenery on the banks was monotonous in the extreme. There was a dense growth of mangroves and other moisture-loving trees. With the exception of flying-foxes and screaming, gaudy-coloured birds, there was an entire absence of animal life. Occasionally they came to ill-made native huts, from which a track through the swamp led to some acres of raised ground like an oasis in a desert; these were carefully cleared, and cultivated with yams, taros, bananas, etc. Here also were permanent houses, built, as usual, on poles some eight feet from the ground, with one room only, common to the whole family. Immediately on their appearance the natives hid themselves in the swamp. It appeared marvellous how human life could exist in such a malarious place. Even in the glare of a noon-day sun the air was thick with mosquitoes.

In Robert Hall Sound the ship was always crowded with natives, fresh parties from distant parts of the coast arriving each day. They are a dark copper-coloured race, combining both dark and light shades, decently clothed—the men wearing a breech cloth, the women the usual ti-ti, or South Sea petticoat. The men have their hair frizzled out in a mop, but the women cut theirs short, and tattoo their bodies extensively, which the men never do. They ornament themselves with black, white, and red pigments, variously laid on, and fasten bunches of bright flowers and the plumes of the Birds of Paradise to their heads and shoulders. Occasionally the great beak of the Toucan was worn as horns on each side of the head. The men's mouths were all much disfigured from the excessive use of the betel-nut. Their weapons are bows, arrows, spears, and clubs made of wood and stone. They were totally unacquainted with the use of iron, and infinitely preferred their own stone hatchets to our axes. The barter they most liked was the polished pearl-shells of Torres Strait.

None of their villages are visible from the sea, being placed in the bush in cleared spaces, which are very neat and cleanly kept. In the rear of the villages are generally extensive, well-fenced plantations of yams, bananas, etc. They gladly received their white visitors at the villages. No signs of cannibalism were visible, and they appeared to be a friendly, intelligent people.

Being so distinct a race from the black, naked New Guinea men of Torres Strait, it will be very interesting to ascertain where the line of demarcation occurs. It is, however, probably not far to the west of Yule Island, for at Cape Possession (25 miles to the west), in 1846, Lieut. Yule remarks that the natives varied in shade from nearly black to a light copper colour. Perhaps it is at some spot where the betel-nut first grows to the east of Torres Strait, for the black race never use this, while the light race always do. Some fine specimens of steel sand were found on the mainland near the sea.

During the south-east monsoon Redscar Bay is a wild, exposed anchorage, the surrounding country low, swampy, and malarious, and intersected by many large streams flowing from the Owen Stanley range. Four or five days were spent in vain efforts to reach the mountains by means of these rivers, but in every case after ascending 12 or 14 miles, where the country began to be somewhat open, the current was so rapid, and snags and uprooted trees so numerous, that it was impossible to go further. The river banks are very similar to those at Robert Hall Sound, but are more frequently fringed with a kind of palm without any trunk, but with gigantic leaf-branches forty or fifty feet arching across the river. Some smaller species were armed with innumerable hooks on the edges of the leaves, which lacerated the explorers when, trying to avoid the current, they kept close to the bank. When clear of the swamp the rivers ran between dense tropical forests, the trees of no great girth, but towering to almost fabulous heights—200 to 250 feet—but even this height could not save them from the destructive climbing parasites, which, reaching to the loftiest branches, destroyed their life and hung round the dead limbs in most weird and fantastic shapes.

The largest of the rivers was blocked by an accumulation of logs and snags, which, having become interlaced, formed a bridge over the river, and being continually added to from above had assumed the shape of large vegetated islands, under which the river rushed and foamed furiously. Just below these islands the river was about 80 yards broad, 20 feet deep, and very rapid. At night they suffered terribly from mosquitoes. Not a sign of natives was anywhere seen, but the natives at Redscar Bay said a powerful tribe lived inland, of whom they were much afraid.

Redscar Bay is the ill-chosen site of a Polynesian native mission, belonging

to the London Missionary Society, where the unfortunate teachers, little better than children themselves, are left to their own resources, and are dying off rapidly.

Immediately to the east of Redscar Head the outlying Barrier reef rears itself to the surface of the water, at a distance varying from three to eight miles from the shore, and guards the coast uninterruptedly as far as Hood Point from any rough seas. Simultaneously with the appearance of this guarding reef the entire features of the country change. The whole coast between Torres Strait and Redscar Head is, as a rule, low and swampy, and has probably been formed during the course of ages by the alluvial deposits of the numberless large streams that descend from the great Owen Stanley range. Here precipitous, round-topped, grassy hills, openly timbered and bearing a strong family likeness to each other, spring from the white coral and sand beach, and are backed up by higher ranges inland, while fertile valleys lie between. The coast is strewn with villages, always marked by a grove of cocoa-nut trees. The houses are built after the Malay fashion, on poles, some standing far out on the shore reefs in quiet waters, while others cluster among plantations on the hill-sides. Perhaps this singularly sudden change from a low, muddy, mangrove-bound coast, to boldness, coral, shells, and white sand is caused by the courses which the rivers from the mountains take. From Redscar Head to Hood Point not a single stream was seen emptying itself into the sea ; small trickling rivulets and water-holes were found, but no clear, running stream. The soil is of a peaty, black, spongy nature, and probably absorbs the rain as it falls.

Close to the Fisherman Islands of Captain Stanley, the " Basilisk " passed inside the Barrier reef by one of those narrow bottomless openings peculiar to these seas, and anchored in a fine roomy harbour within a harbour (now named Port Moresby and Fairfax Harbour), previously discovered by the boats. The ship remained here some days whilst running surveys were made and the coast explored. In the neighbourhood of Port Moresby the valleys are intensely rich and tropical in their vegetation, but the hills, of which the greater part of the country consisted, were perfectly Australian in their appearance. They had very poor soil, covered with large stones, scattered gum trees, and grass. On some of the hills large quantities of quartz were found, some specimens being impregnated with gold, but no trace of gold was ever discovered among the natives.

The description of the Yule Island natives may generally be applied to the natives of this part of the coast, but they appear even a more harmless and inoffensive race, only one having been seen armed during the month spent amongst them. The canoes, which trade up and down the coast for long distances, calling at different villages, were frequently examined and found to

be equally destitute of weapons. Many of their canoes were of the kind described by Lieut. Yule, of H.M.S. "Bramble," in 1846, viz., double canoes with a cane deck or platform passing over all and fastening the canoes together. They are propelled by large mat-sails spread between two poles in the shape of the letter V, and steered with long paddles. Their length was about 40 feet, and extreme beam about 8 feet. No treble or quadruple canoes of this description were seen.

In their houses these natives had rough wood spears, and occasionally stone clubs, but no bows. "We roamed over the country and visited their villages as freely as if they were English people. If any of our fellows got lost in the bush the natives took them to their villages, fed them, and offered every hospitality before bringing them back to the ship. Apparently they had never before seen a white man, and their curiosity was great to see and touch our white skins." From their proximity to Redscar Bay they had learnt the use of iron, and eagerly took axes in barter. Their fishing nets, made from the fibre of a small nettle-like plant, are precisely similar to an English seine, quite as strong, and are universally used from Yule Island to East Cape. Wallabies were the only wild animals; pigs and dogs, the domesticated ones, seen.

Commencing at Heath Point—where Captain Stanley began his running survey of New Guinea—distant about 40 miles from the then supposed south-eastern extremity, the chart shows an unbroken continuation of the Owen Stanley Range to near the supposed South-East Cape. The north-east shores of New Guinea had never been examined, but all the charts agree in representing its eastern termination to be in the shape of a wedge, with D'Entrecasteaux Island on its north-east board. "The reality we have found to be very different, as the rough tracing will show. You will observe that New Guinea finishes its enormous length to the eastward in the form of a broad fork. Heath Point of Captain Stanley is a lofty island lying off the mainland. Thus Captain Stanley, in reality, commenced his survey at the extreme south-east point of New Guinea without being aware of it. It was probably thick weather when his soundings were taken within two miles of Heath Island. Under any circumstances, from the westward, Heath Island shuts out all view of the strait named by me 'China Strait.' The tracing will obviate my making any lengthened remarks on the unexpected configuration of the land which it has been our lot to discover. I will briefly say that the south-east extremity of New Guinea sweeps precipitously down from a height of about 2,000 feet to the tranquil shores of China Strait." On the opposite side is Hayter Island, irregularly shaped, rising to a height of about 800 feet. Hayter Island is separated by a narrow pass (riven asunder by some mighty convulsion of nature) from Mourilyan Island. The latter is of a moderate

height on its southern board, but to the north-east rises to about 1,200 feet, and is separated by Fortescue Strait from Moresby Island, a noble island with peaks nearly 2,000 feet high.

"It is a curious question how it has come about that the mistake of supposing New Guinea to end in a wedge-like shape should have occurred. It may have been that D'Entrecasteaux and the old navigators knew of the existence of the north-east fork, and placed their discoveries relatively correct with regard to it, while they knew nothing of the south-east fork. Modern navigators—making the land from the south—knowing nothing of the north-east fork, and seeing high land of that part of New Guinea over the low land of Mourilyan Island, hastily jumped to the conclusion that it must be D'Entrecasteaux Island. Thus confusion arose and the fork was *shut up*. It is clear enough now.

"I am strongly of opinion that the route between China and Australia will eventually lead through China Strait, which is free from danger and has safe anchorage everywhere. A ship leaving Sydney would follow the outside route to the great north-east channel, a clear, free sea from that well-known track leading to China Strait, thence to East Cape is a clear run." There the "Basilisk" was brought up by reefs. Unfortunately a want of stores and fuel prevented them looking for a passage to the south of Lydia Island, which Captain Moresby thinks will undoubtedly be found. He examined the northern shores of New Guinea for about 25 miles in a boat. "Once round East Cape New Guinea is washed by a grand, clear, reefless sea. A ship might literally sail with her sides rubbing against the coral wall which binds the shore, and find good anchorage in any of the bays where a beach is seen. How far to the westward this description would apply remains to be proved. Of the beauty and fertility of these islands and shores of New Guinea it is impossible to speak too highly. In its general features it strongly reminded me of Jamaica. The precipitous wooded mountains are to a considerable extent cleared and terraced to their very summits with taro and yam plantations, in a way that even a Chinaman might envy, while the valleys produce cocoa-nuts, sago, palms, bananas, sugar-cane, oranges, guavas, pumpkins, and other tropical productions. Mountain streams abound, and contain a delicious eating fish, almost identical in taste and appearance with the English trout." The torrents which discharge into Sir Alexander Milne Bay are very numerous and large.

At the head of Sir Alexander Milne Bay fine specimens of steel-sand were obtained. At East Cape the natives possessed large lumps of obsidian, but they did not observe that it was used to barb spears or make knives of, as at the Admiralty Islands.

The whole of these coasts, except where the mountains rise too precipitously

from the sea to give foothold to man, which is often the case, are thickly populated. The natives are of a lighter copper-colour than those previously described, slightly limbed and active, with bright, intelligent features, some of them of a decidedly Jewish cast, with light hair. Many would be good-looking but for the disfigurement caused by the betel-nut. Their taste in painting themselves is peculiar. At one time they make themselves a sooty black with charcoal and oil; at another they will paint black spectacles round their eyes, blacken the nose, and lime their cheeks and chins white, giving themselves a most grotesque appearance. They are fond of wearing bright flowers, birds' plumage, and long ornamented streamers of the *Pandanus* fastened to their shoulders. In some instances the septum of the nose was perforated and a polished bone thrust through. Occasionally they wore human jaw and spinal bones as bracelets and ornaments. The women wore their hair short and were extensively tattooed, the men never. They are fond of making pets of parrots, cassowaries, and different species of a sloth-like marsupial little animal, which, from being somewhat like the Australian bear, was named the opossum bear. One species, with a soft greyish fur, was very beautiful, but attempts to keep them alive on board ship were unsuccessful. The men appear to do all the canoe work, fishing, etc., leaving the field labour for the women, who, nevertheless, appeared to have their say, and make the men do as they pleased in matters of barter. The men were frequently seen nursing little children with much affection.

A striking distinguishing mark of the superior civilization of the light-coloured race to the black New Guinea men is the acquaintance of the latter with the art of common pottery. At all their villages earthenware pots of various sizes were seen, and others were in process of manufacture. They are neatly moulded by hand to the required shape, and then baked by heaping fire round the clay.

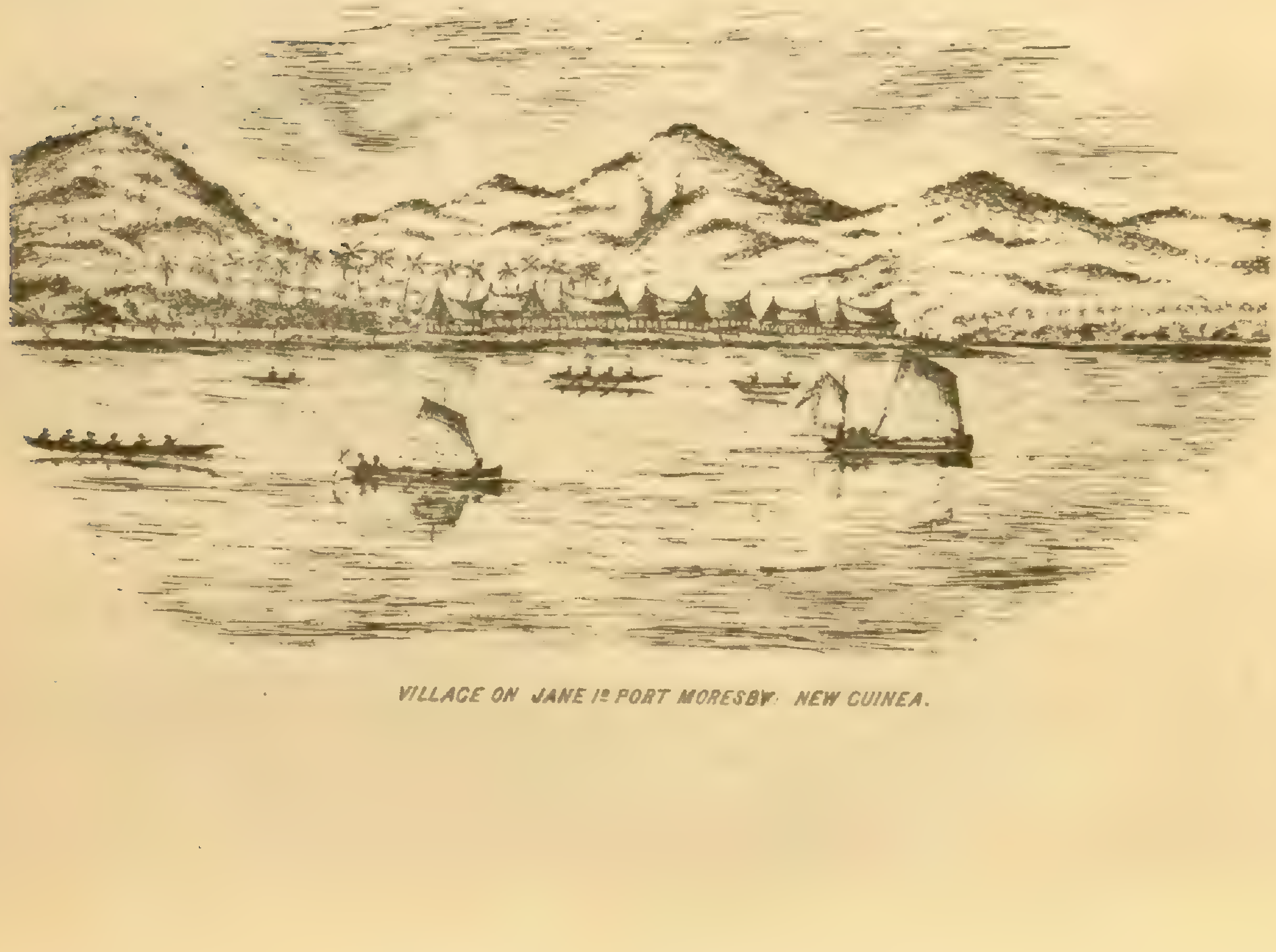
Their weapons are handsomely-carved wooden swords, clubs, and shields, wooden spears and stone tomahawks, but no bows. They were perfectly aware of the value of iron, specimens being found in every village, which were doubtless obtained from the eastern islands, with which constant communication is maintained by means of large trading canoes 40 to 50 feet long. The bottom of the canoes is a hollowed tree, which is built upon, and the top-sides secured by a strong cane lacing and large wooden knees. They are propelled by an oval-shaped mat sail, are very skilfully handled, and quite capable of making long voyages. "Meeting them at sea, the 'Basilisk' going five knots, they easily sailed round us, and, luffing up under our lee, were with difficulty prevented from boarding whilst we were under way." The other canoes are small, and the catamaran is universal. Besides these each village has several long, narrow war canoes, highly ornamented after a barbarous fashion, carved

and painted, which are capable of holding 40 or 50 men. They are kept very carefully hauled up under sheds, and have the appearance of being but seldom used.

"With these people our intercourse was of a most satisfactory and pleasant nature. At first they were a little shy, but this was speedily got over, and a free interchange of barter went on, pieces of hoop-iron being the great medium of exchange. They eagerly gave their handsome stone hatchets and other valuables for a piece of the coveted iron, with which many tons of the finest yams were also bought. Looking glasses seemed at first to alarm them. On all possible occasions I gave our ship's company liberty to go on shore and mix freely with the natives, and the results were all I could desire—perfect good feeling and confidence on both sides; nor was there a single instance of our men insulting the women, or of the natives making immoral offers. The greater part of our surveys being done in boats, I had frequent occasion to land in my six-oared galley at large populous villages, 18 or 20 miles from the ship, surrounded by large crowds, yet we were always received in the same friendly, hospitable spirit as if in sight of the ship, nor do I think they had any idea that we possessed weapons more powerful than their own. They would, if possible, pilfer when on board, but in bartering were strictly honest. Taking them altogether they are as genial and pleasant a race of savages as could well be met. At the same time I have no doubt they do a little cannibalism among themselves. They took pains to make us understand, as an event they were proud of, that they had eaten the former owners of the skulls hung up in their villages, and of the human bone ornaments which they wore; but as the skulls are few and apparently of ancient date, and they have superabundance of food, I am inclined to think it is only on very rare occasions that they make a raid or do any fighting among themselves. I never saw a wounded man amongst them. I think it not at all unlikely that the inhabitants of the large outlying islands stand very much in relation to the New Guinea men as the Danes and Norsemen of old did to the ancient Britons. On one occasion, when lying in Fortescue Strait, we were visited by some large island canoes, and immediately they appeared every mother's son of the New Guinea men cleared out, and were seen no more until the strangers had left.

"We could not trace any sign of religious worship amongst any of these copper-coloured races, unless stringing up thousands of cocoa-nuts on poles fixed on the reef in front of their villages—in fact, everywhere—may be regarded as a propitiatory offering. They never were out after dark, and probably, like other savages, have a belief in and dread of devils and evil spirits, but no knowledge of any good spirit. At Killerton Island, before they opened a friendly intercourse, they brought a dog on board and knocked

DISCOVERY BAY.



VILLAGE ON JANE I^D PORT MORESBY. NEW GUINEA.

out its brains on the quarter-deck, looking upon the rite as a ratification or sealing of friendship—at least so we understood it.

"The natives appeared to be subject to a kind of leprosy and other skin diseases, but elephantiasis—so common in Torres Strait as a cause of malformation—was scarcely ever seen.

"The meteorology of the coast of New Guinea, from Yule Island to the eastward, was found—during the months of February, March, April, and May—to differ materially from that of Torres Strait. Leaving Torres Strait the first week in February, when heavy rains and occasional stormy breezes with dirty weather from the north-west prevailed, we remained in the neighbourhood of Redscar Bay until the first week in March, during which time we only had one day's wet weather and strong breeze; all the rest were fine with calms and light variable winds. At Cape York, again, in March, we had a constant succession of heavy rains and dirty weather. On March 30th we were again at New Guinea, with lovely weather, and thus it continued, excepting two days' rain (27th and 28th April), until we finally left China Strait, on 7th May. On 10th May, off Mount Suckling, the south-east monsoon set in strong, with rain. This was immediately following after three days dead calm. At Cape York the south-east monsoon had been blowing steadily since the end of March.

"The barometer had been steady at 29·80, or thereabouts, and the thermometer has ranged between 82° and 88°, but the heat was rarely felt oppressive, and our ship's company—although they have served almost continuously for the last eighteen months in tropical climates, and our boats' crews have been much exposed in surveying the rivers and creeks—have enjoyed general good health.

"Referring again to the natives, I think you will now agree with me that the ferocious character assigned, on no authority, to these poor New Guinea savages may be dropped. Wandering through their peaceful, luxuriantly-planted villages, it often made me sad to think that our discoveries must inevitably, sooner or later, bring white men among these contented creatures, with sin, disease, and misery in their train."

A Catalogue of the Neuropterous Insects of New Zealand; with Notes and Descriptions of new Forms. By Robert M'Lachlan, F.L.S.

[Reprinted from Ann. and Mag. N.H., July, 1873.]*

It has been represented to me that the entomologists of New Zealand are greatly in need of classified lists of the insects of that colony, and that any contribution in this way would be welcome. Acting upon this suggestion, I have drawn up a catalogue of the New Zealand Neuroptera (in the Linnean sense). The task has not been difficult; for, including three new species here described, the total number of insects of the order at present known to inhabit the colony barely exceeds forty-five species; and some of these are yet doubtful, pending further information. Nearly half of them are Trichoptera, which division appears to be the best represented; or it may be that they are best known only because a friend, knowing my *penchant* for these insects, has collected them more assiduously.

Owing to the proximity of New Zealand to the Australian continent, and to the fact that some few species are common to both, it may not be uninteresting to give a brief comparative sketch of the various Neuropterous families as regards their numerical strength in the two districts, so far as present knowledge will permit. The physical conditions of Australia and New Zealand are so different that a considerable discrepancy might naturally be expected; but, owing to its ramified water system and comparative freedom from drought, the advantage ought to be on the side of the latter. Let us see, then, how this idea is affected by the apparent facts. I will commence with the Odonata (Dragonflies). In Australia all the tribes (excepting Calopterygina) are tolerably abundant. From New Zealand I know of only eight species; the great tribe Libellulina is wholly absent; the Corduliina are represented by three species of Australian facies; the Æschnina by one Australian species; the Gomphina by one (*Uropetala*), a magnificent insect of an Australian group; the Calopterygina are absent, but are almost so in Australia; of the Agrionina there are only three species. Of other Pseudo-Neuroptera the Termitidæ, Ephemeridæ, and Perlidæ have a few representatives in both; the Psocidæ are not known from New Zealand, and but few have been noticed in Australia; but this is probably owing to their minute size. Among the Planipennia, New Zealand and Australia have each a species of Sialidæ (*Chauliodes*); the former has only one ant-lion (Myrmeleontidæ), though they are common in the latter; Ascalaphidæ appear to be wanting in the former, and tolerably well represented in the latter; and the same remark will apply to Chrysopidæ and Mantispidæ. Australia has one species of Nemopteridæ

* Printed at the suggestion of the Philosophical Institute of Canterbury. See Report of Cant. Phil. Inst. for 1873, presented 5th Nov., 1873, in Proceedings *(post)*.—Ed.

and a few Panorpidæ, neither of which are known from New Zealand; while Hemerobiidæ and Osmylidæ are feebly represented in both; the Nymphidæ, an almost peculiarly Australian family, are unknown in New Zealand. In Trichoptera alone does New Zealand appear to have the advantage over Australia.

The paucity of species of Dragonflies is very remarkable; and one is tempted to believe that in New Zealand there must be a scarcity of aquatic insects both as larvæ and otherwise, and of those aërial insects upon which the perfect Dragonflies prey. Another point strikes me; and that is the small number of aphidivorous Planipennia, the chief of which (the Chrysopidæ) are unrepresented. Can it be that indigenous Aphides are happily almost unknown there? It may be that the ideas here thrown out are based upon erroneous premises; and if so it behoves the entomologists of New Zealand to set me right by producing a fair sample of the insect fauna of their colony.

The list of Trichoptera here given is scarcely more than a reprint of that already published by me in the 'Journal of the Linnean Society' (Zoology), vol. x. Much of the material from which the entire list is compiled has been received from my friend Mr. R. W. Fereday, of Christchurch, and from Mr. H. Edwards, who was for some time at Auckland; nor must the collections formed by Dr. Sinclair, Mr. Colenso, Dr. Hooker, Col. Bolton, the naturalists of the 'Novara,' etc., be forgotten. No special localities are given, because many of the insects are noted simply as from New Zealand without further indication.

In the references I have indicated by an asterisk where the best description of each species may be found; and if this sign occurs so frequently in connection with my own descriptions, the reader must please consider that I do not claim for them any special excellence, and that it is owing to the fact that in most cases no others exist.

PSEUDO-NEUROPTERA.

Termitidæ.

Genus Calotermes, Hagen.

1. *Calotermes insularis*, White.

Termes insularis, White, Zool. of Voyage of 'Erebus' and 'Terror'†; Walk. Brit. Mus. Cat. Neuropt. pt. iii. p. 522. *Calotermes insularis*, Hagen, Linnæa Entomologica, Band xii. p. 42*; *id.* Brit. Mus. Cat. Neuropt. (Termit.), p. 2.

Also found in New Holland.

2. *Calotermes improbus*, Hagen.

Calotermes improbus, Hagen, Linnæa Entomologica, Band xii. p. 44*; *id.* Brit. Mus Cat. Neuropt. (Termit.), p. 6; Brauer, Reise der 'Novara,' Neuropt. p. 45.

Hagen described a wingless example from Van Diemen's Land. Brauer described the winged form of what he considers to be the same species from New Zealand.

† I have not been able to verify this reference.

Genus Stolotermes, Hagen.

3. *Stolotermes ruficeps*, Brauer.

Stolotermes ruficeps, Brauer, Reise der 'Novara,' Neurop. p. 46.*

Perlidæ.

Genus Stenoperla, M'Lachlan.

4. *Stenoperla prasina*, Newman.

Chloroperla prasina, Newman, Zoologist, 1845, p. 853.* *Hermes prasinus*, Walk. Brit. Mus. Cat. Neuropt. pt. ii. p. 206. *Stenoperla prasina*, M'Lachl. Trans. Ent. Soc. ser. 3, vol. v. p. 354.*

Genus Perla, Geoffroy.

5. *Perla* (?) *cyrene*, Newman.

Chloroperla cyrene, Newman, Zoologist, 1845, p. 853.* *Perla* (?) *cyrene*, Walk. Brit. Mus. Cat. Neuropt. pt. i. p. 168.

This insect is certainly not a *Chloroperla*, nor is it a *Perla* as restricted. The wings are densely reticulate with cross veinlets. I have seen no examples in good condition.

Genus Leptoperla, Newman.

6. *Leptoperla opposita*, Walker (?).

Perla opposita. Walk. Brit. Mus. Cat. Neuropt. pt. i. p. 171.

Walker mentions two examples from Van Diemen's Land and one from New Zealand; but I much doubt if this latter is specifically identical with those from Tasmania.

I have seen two or three more species of Perlidæ from New Zealand, but await additional information before describing them. One is an insect with the *facies* of *Nemoura* or *Tæniopteryx*, but with short caudal setæ.

Ephemeridæ.

Genus Leptophlebia, Westwood;
Eaton, Trans. Ent. Soc. Lond. 1871, p. 77.

7. *Leptophlebia dentata*, Eaton.

Leptophlebia dentata, Eaton, Trans. Ent. Soc. Lond. 1871, p. 80, pl. iv., figs, 18 & 18 *a–d* (details).*

8. *Leptophlebia nodularis*, Eaton.

Leptophlebia nodularis, Eaton, Trans. Ent. Soc. Lond. 1871, p. 81, pl. iv., figs. 20 & 20 *a–c* (details).*

Genus Coloburus, Eaton, Trans. Ent. Soc. Lond. 1871, p. 132.

9. *Coloburus humeralis*, Walker.

Palingenia humeralis, Walk. Brit. Mus. Cat. Neuropt. pt. iii. p. 552 (female subimago). *Baetis remota*, Walk. *op. cit.* p. 564 (imago). *Coloburus humeralis*, Eaton, Trans. Ent. Soc. 1871, p. 132, pl. iii. fig. 3 (wing), pl. vi. figs 6 & 6 *a*, *b* (details).*

I possess yet two species of Ephemeridæ from New Zealand, one of which may be the Australian *Leptophlebia costalis*, Burmeister.

Odonata.

Tribus CORDULIINA.

Genus CORDULIA, Leach, Selwys.

10. *Cordulia smithii*, White.

Cordulia smithii, White, Zoology of Voyage of 'Erebus' and 'Terror," pt. xi. pl. vi. fig. 2 (female); Selys, Syn. Cordulines, p. 27. *C. novæ-zealandiæ*, Brauer, Verh. zool.-bot. Ges. Wien, 1865, p. 501; *id.* Reise der 'Novara,' Neuropt. p. 78, t. ii. figs. 3–3*b*.*

Genus EPITHECA, Charpentier.

11. *Epitheca grayi*, Selys.

Epitheca (Somatochlora) grayi, Selys, Syn. Cordulines, p. 49.*

12. *Epitheca braueri*, Selys.

Epitheca (Somatochlora) braueri, Selys, Syn. Cordulines, p. 50.*

Tribus GOMPHINA.

Genus UROPETALA, Selys.

13. *Uropetala carovei*, White.

Petalura carovei, White, Zoology of Voyage of 'Erebus' and 'Terror,' pt. xi. pl. vi. fig. 1 (male); *id.* in Dieffenbach's Travels in New Zealand, vol. ii p. 281; Selys, Syn. Gomphines, p. 92. *Uropetala carovei*, Selys, Mon. Gomphines, p. 370, pl. xix. fig. 2 (details)*; *id.* Secondes Addit. Syn. Gomphines, p. 42.

Tribus ÆSCHNINA.

Genus ÆSCHNA, Fabricius.

14. *Æschna brevistyla*, Rambur.

Æschna brevistyla, Ramb. Hist. Névropt. (Suites à Buffon), p. 205.*

I received three examples of this Australian species from Mr. Henry Edwards, labelled "New Zealand;" and although that gentleman also collected in the neighbourhood of Melbourne, there is no reason to suspect any confusion of locality. The Æschnina are insects of notoriously wide distribution and great power of wing.

Tribus AGRIONINA.

Genus LESTES, Leach.

15. *Lestes colensonis*, White.

Agrion colensonis, White, Zoology of Voyage of 'Erebus' and 'Terror,' pt. xi. pl. vi. fig. 3 (male). *Lestes colensonis*, Selys, Syn. Agrion. (*Lestes*), p. 44.*

Genus TELEBASIS, Selys.†

16. *Telebasis zealandica* ‡, n. sp.

𝔐. Caput supra nigrum, longe brunneo-pilosum, antice et postice cum nasi margine labroque (macula mediana nigra excepta) sanguineum; ore flavido. Pronotum nigrum, marginibus maculisque tribus sanguineis; margine postico fere semicirculari. Thorax supra niger, inter alas sanguineus, lineis duabus sanguineis; ad latera rubescens, lineis duabus brevibus ad alarum bases nigris. Pedes sanguinei,

† The characters of *Telebasis* are briefly indicated in a note appended to the introduction to his 'Synopsis des Agrionines,' 5me légion, p. 4. The chief character is that the wings are petiolated up to the first basal postcostal nervule.

‡ De Selys, MS.

nigro-spinosi, tarsorum apicibus nigro-terminatis. Abdomen sanguineum, ad apicem obscurius; macula quadrata ad basin segmenti basalis, juncturis lineaque utrinque apicem versus nigris; segmento ultimo supra in medio exciso; appendicibus superioribus parvis, sanguineis, intus tuberculo nigro instructis; inferioribus elongatis, subforcipatis, sanguineis, nigro terminatis. Alæ vitreæ; pterostigmate rufo-brunneo vel flavido.

𝔉. Caput thoraxque fere ut in 𝔐, sed colore sanguineo in flavum mutato; labro postice evidenter nigro-marginato. Pedes pallidiores; femoribus supra infuscatis. Abdomen supra nigrum, juncturis (ad apicem exceptis) flavis; infra flavum.

𝔐. Long. corp. 14–15‴, long. abdom. 11–12‴; exp. alar. 16–17‴, long. alæ postic. 8–8½‴. 𝔉. Long. corp. 15‴, long. abdom. 11¼‴; exp. alar. 19‴, long. alæ postic. 9‴.

Male. Head and thorax above black, with long brownish hairs. Hinder and anterior margins of the head, the front margin of the nasus, and the labrum wholly (excepting a black spot in the middle) red; under lip yellowish; second joint of the antennæ red, black at the apex. Pronotum with the margins and three discal spots red; posterior margin nearly semicircular, very slightly produced in the middle. Two bright red lines on the thorax above; the sides reddish, with two short black streaks, one under the base of each wing; there is also an appearance of two lines paler than the ground-colour. Legs bright red, with black spines; the tips of the tarsal joints black. Abdomen bright blood-red; a quadrate black spot above at the base of the first segment; the sutures of all the segments with a black ring; on the sides a black subapical line, commencing at the apex of segment 6, continuous on segment 7, and nearly so on segment 8, but not there reaching the margins; segment 10 excised in the middle above; superior appendages short, only slightly exserted, subtriangular, red, with a black tubercle internally; inferior appendages somewhat forcipate, long, red, with the tips black and pointed. Wings hyaline, narrow; veins black, slightly reddish at the base; pterostigma reddish brown (yellowish in immature examples), in the form of an irregular lozenge, the upper edge much longer than the lower, surmounting one cellule; in the anterior wings the upperside of the quadrilateral is more than one-half shorter than the lower, in the posterior wings about one third shorter; thirteen to fourteen post-cubital nervules in the anterior wings; three cellules between the quadrilateral and the nodus.

Female.—All the markings of the head and thorax that are red in the male are here yellow; the base of the labrum has a distinct black line; on the prothorax there are only two spots instead of three. Legs yellowish, the femora fuscous above. Abdomen bronzy black above, pale yellowish beneath; segments 1–6 above with a yellow half-ring at the base of each; appendages short, conical, blackish; vulvar valves yellow, the terminal appendages black.

I have examined several males and females of this species.

17. *Telebasis sobrina*, n. sp.

𝔐. *T. zealandicæ* valde affinis, sed major; appendices superiores multo longiores, inferioribus dimidio tantum breviores. Long. corp. 18‴, long. abdom. 15‴; exp. alar. 22‴, long. alæ postic. 10½‴.

Very closely allied to *T. zealandica*, but considerably larger; on the abdomen the basal spot at the base of segment 1 is divided; the superior appendages are much exserted, scarcely one half shorter than the inferior, subtriangular, the lower edge concave, hence the tips are much curved downward (the black tubercle is present as in *T. zealandica*). There are four cellules between the quadrilateral and the nodus in all the wings, and the pterostigma is larger and surmounts fully two cellules; fifteen postcubital nervules in the anterior wings.

Notwithstanding the great similarity I must, for the present, consider this insect specifically distinct from *T. zealandica*. Only one male has been examined, and that rather immature, the red markings on the head and thorax not being fully developed and more or less yellowish, and the pterostigma dusky yellow.

PLANIPENNIA.

Sialidæ.

Genus CHAULIODES, Latreille.

18. *Chauliodes diversus*, Walker.

Hermes diversus, Walk. Brit. Mus. Cat. Neuropt. pt. ii. p. 205. *H. dubitatus*, Walk. *op. cit.* p. 204* (*cf.* M'Lachlan, Ann. & Mag. Nat. Hist. July 1869, pp. 37 & 39).

This insect varies much in size. Of five individuals in my collection the smallest (male) has an expanse of wings of only 25‴, the largest (female) expands to 41‴. The structure of the antennæ is the same in both sexes.

Myrmeleontidæ.

Genus MYRMELEON, Linné, Hagen.

19. *Myrmeleon acutus*, Walker.

Myrmeleon acutus, Walk. Brit. Mus. Cat. Neuropt. pt. ii. p. 377.*

Appears to be the sole representative in New Zealand of this extensive family. The hind wings of the male possess a "*pelote*" or knob at the extreme base of the inner margin, as in many other species.

Osmylidæ.

Genus STENOSMYLUS, M'Lachlan.

The New Zealand species might be transferred to a new genus on account of the subfalcate wings and excised apical margin; but the Australian *S. pallidus* is in some respects intermediate between them and the typical species; hence their retention in this genus will answer every purpose, at any rate for the present.

20. *Stenosmylus incisus*, M'Lachlan.

Osmylus incisus, M'Lachl., Journ. of Entom. vol. ii. p. 112, pl. vi. fig. 1* (*cf.* M'Lachl., Entom. Monthly Mag. vol. vi. p. 195).

21. *Stenosmylus citrinus*, n. sp.

S. forma *S. incisi.* Citrinus. Frons obscurior, supra nigricans. Thorax utrinque niger. Tibiæ anticæ et intermediæ (femoraque postica) ad apices et in medio fusco semicinctæ. Alæ anticæ punctis nigris conspersæ; macula discali subapicali, nonnullisque parvis ad marginem apicalem et internum albidis, nigro marginatis; posticæ pallidiores, punctis nigris subobsoletis solum ad costam, maculis albidis nullis. Abdomen infuscatum. Long. corp. 7‴; exp. alar. 27‴.

The whole insect is of a delicate citron colour, excepting the abdomen, which is infuscate; but the colour of this part is probably changed in dry examples. On the face the colour becomes obscured, and below the base of the antennæ it is blackish. On the pronotum anteriorly there is a trace of a black median longitudinal line, and the sides are broadly black, with black hairs; the meso- and metanota have the sides broadly infuscate, bordered by a black line. The anterior and intermediate tibiæ have a black spot at each end and in the middle; the posterior femora are somewhat infuscate, darker at each end, and with a trace of a black spot in the middle; all the legs are clothed with citron-coloured hairs. The anterior wings have many small black dots, those below the radius, and two discal ones, larger than the others; at the end of the first branch of the sector and the upper cubital vein, before the apex, is a conspicuous irregular whitish spot margined with black, and along the excised apical margin and on the inner margin are smaller whitish spots, margined with blackish internally, or with a blackish dot on each side; the sector has sixteen principal branches; the inner series of gradate nervules is rudimentary. The posterior wings are paler than the anterior, without whitish spots; and the black dots are only faintly indicated on the costal margin.

A very beautiful insect, of the same form as *S. incisus.*

Hemerobiidæ.

Genus Drepanopteryx†, Leach.

22. *Drepanopteryx instabilis*, M'Lachlan.

Drepanopteryx instabilis, M'Lachl. Journ. of Entom. vol. ii. p. 115, t. vi. fig. 4.*

Found also in Australia without apparent specific difference. Most of the New Zealand examples (but not all) pertain to the variety indicated at fig. 4* with a large whitish costal spot in the fore wings; but at present I see nothing to indicate that these form a distinct species.

23. *Drepanopteryx humilis*, M'Lachlan.

Drepanopteryx humilis, M'Lachl. Journ. of Entom. vol. ii. p. 116, pl. vi. fig. 5.*

Found also at Moreton Bay. The smaller size seems to indicate that this is not a form of *D. instabilis.*

† According to the characters of the genera *Drepanopteryx* and *Megalomus* as laid down by Brauer (*cf.* 'Verhandl. zool.-bot. Gesellschaft in Wien,') 1866, p. 987, the two New Zealand species and the Australian *D. binoculus* ought perhaps to be placed in the last-named genus.

Genus MICROMUS, Rambur.

24. *Micromus tasmaniæ*, Walker.

Hemerobius tasmaniæ, Walk. Trans. Ent. Soc. Lond. ser. 2, vol. v. p. 186.*

I have two examples which scarcely appear to differ specifically from others from Australia; but it is desirable that long series of both Australian and New Zealand specimens should be compared. The insect has the costal area of the fore wings narrowed at the base, and without a recurrent nervule, and hence is a *Micromus* and not a *Hemerobius* as restricted.

TRICHOPTERA.

Sericostomatidæ.

Genus ŒCONESUS, M'Lachlan.

25. *Œconesus maori*, M'Lachlan.

Œconesus maori, M'Lachl. Trans. Ent. Soc. Lond. ser. 3, vol. i. p. 303;* *id.* Journ. Linn. Soc. Zool. vol. x. p. 211, pl. ii. fig. 1 (neuration), male.

I now possess the female of this insect; it differs from the male in its larger size; the neuration of the anterior wings is regular; and in the posterior wings there are two additional apical forks. The maxillary palpi are 5-jointed, the basal joint very short, the second slightly longer, the third to fifth still longer and nearly equal *inter se*.

Genus OLINX, M'Lachlan.

26. *Olinx feredayi*, M'Lachlan.

Olinx feredayi, M'Lachl. Journ. Linn. Soc., Zool. vol. x. p. 198, pl. ii. figs. 2–2*d* (details).*

Genus PYCNOCENTRIA, M'Lachlan.

27. *Pycnocentria funerea*, M'Lachlan.

Pycnocentria funerea, M'Lachl. Trans. Ent. Soc. Lond. ser. 3, vol. v. p. 252, pl. xviii. fig. 1 (details).*

28. *Pycnocentria evecta*, M'Lachlan.

Pycnocentria evecta, M'Lachl. Journ. Linn. Soc., Zool. vol. x. p. 199, pl. ii. fig. 3 (details).*

29. *Pycnocentria aureola*, M'Lachlan.

Pycnocentria aureola, M'Lachl. Journ. Linn. Soc., Zool. vol. x. p. 200, pl. ii. figs. 4 & 4*a* (details).*

HELICOPSYCHE.

This term was applied to certain cases of the larvæ of Trichoptera found in Europe, which depart from the usual forms and assume a spiral condition, thus resembling small Helices, formed of sand grains neatly cemented together; and this resemblance has often deceived conchologists, who have described them as shells. They have since been found in streams almost all over the world, and their real nature has long been known. Recently in North America the perfect insect of one species has been bred. Three forms occur in New Zealand (*cf.* M'Lachlan, Journ. Linn. Soc., Zool. vol. x. p. 200). There is yet much mystery about the species that form them; and it is possible that

they are the work of more than one genus of Sericostomatidæ. The European forms have not been referred to any particular insects; and in Europe no insect has been discovered that absolutely agrees generically with that bred in America. The same remark applies to those from New Zealand; and I have a suspicion that they may be the work of species of *Pycnocentria*. It is much to be desired that colonial entomologists will investigate this matter; the cases are probably found attached to stones in streams.

Leptoceridæ.

Genus Tetracentron, Brauer.

30. *Tetracentron sarothropus*, Brauer.

Tetracentron sarothropus, Brauer, Verh. zool.-bot. Ges. in Wien, 1865, p. 418; *id.* Reise der 'Novara,' Neurop. p. 12, t. i. fig. 5 (details).* *Pseudonema obsoleta*, M'Lachl. Trans. Ent. Soc. Lond. ser. 3, vol. i. p. 305 (*cf.* M'Lachl. Journ. Linn. Soc., Zool. vol. xi. p. 128).

31. *Tetracentron amabile*, M'Lachlan.

Tetracentron amabile, M'Lachl. Journ. Linn. Soc., Zool. vol. x. p. 201, pl. ii. figs. 5–5*d* (details).*

Genus Notanatolica, M'Lachlan.

32. *Notanatolica cognata*, M'Lachlan.

Leptocerus cognatus, M'Lachl. Trans. Ent. Soc. Lond. ser. 3, vol, i. p. 306.* *Notanatolica cognata*, M'Lachl. *loc. cit.* vol. v. p. 258.

33. *Notanatolica cephalotes*, Walker.

Leptocerus cephalotes, Walk. Brit. Mus. Cat. Neuropt. pt. i. p. 73 (*cf.* M'Lachl. Journ. Linn. Soc., Zool. vol. x. p. 213).

A doubtful species.

Genus Leptocerus, Leach, Hagen.

34. *Leptocerus (?) alienus*, M'Lachlan.

Leptocerus (?) alienus, M'Lachl. Journ. Linn. Soc., Zool. vol. x. p. 202.*

This insect is not a true *Leptocerus* as restricted.

Genus Setodes, Rambur.

35. *Setodes unicolor*, M'Lachlan.

Setodes unicolor, M'Lachl. Journ. Linn. Soc., Zool. vol. x. p. 203, pl. ii. fig. 7 (details).*

Hydropsychidæ.

Genus Hydropsyche, Pictet, Hagen.

36. *Hydropsyche fimbriata*, M'Lachlan.

Hydropsyche fimbriata, M'Lachl. Trans. Ent. Soc. Lond. ser. 3, vol. i. p. 309.*

37. *Hydropsyche colonica*, M'Lachlan.

Hydropsyche colonica, M'Lachl. Journ. Linn. Soc., Zool. vol. xi. p. 131, t. iv. fig. 16 (details).*

Genus Polycentropus, Curtis.

38. *Polycentropus puerilis*, M'Lachlan.

Polycentropus puerilis, M'Lachl. Journ. Linn. Soc., Zool. vol. x. p. 204, t. ii. figs. 8–8*b* (details).*

Genus Hydrobiosis, M'Lachlan.

39. *Hydrobiosis frater*, M'Lachlan.

Hydrobiosis frater, M'Lachl. Journ. Linn. Soc., Zool. vol. x. p. 207, t. ii. figs. 9–9*b* (details).*

40. *Hydrobiosis umbripennis*, M'Lachlan.

Hydrobiosis umbripennis, M'Lachl. Journ. Linn. Soc., Zool. vol. x. p. 208, t. ii. figs. 9 *c*, *d* (details).*

Genus Psilochorema, M'Lachlan.

41. *Psilochorema mimicum*, M'Lachlan.

Psilochorema mimicum, M'Lachl. Trans. Ent. Soc. Lond. ser. 3, vol. v. p. 274, pl. xviii. fig. 4 (details).*

42. *Psilochorema confusum*, M'Lachlan.

Psilochorema confusum, M'Lachl. Journ. Linn. Soc., Zool. vol. x. p. 210, t. ii. figs. 10–10*b* (details).*

Rhyacophilidæ.

Genus Philanisus, Walker.

43. *Philanisus plebejus*, Walker.

Philanisus plebejus, Walk. Brit. Mus. Cat. Neuropt. pt. i. p. 116. *Anomalostoma alloneura*, Brauer, Verh. zool.-bot. Ges. in Wien, 1865, p. 422; *id.* Reise der 'Novara,' Neurop. p. 16, t. i. fig. 6 (details).*

Hydroptilidæ.

Genus Oxyethira, Eaton.

44. *Oxyethira albiceps*, M'Lachlan.

Hydroptila albiceps, M'Lachl. Trans. Ent. Soc. Lond. ser. 3, vol. i. p. 304. *Oxyethira albiceps*, Eaton, *loc. cit.* 1873, p. 145.*

This species was accidentally omitted in my list in 'Journ. Linn. Soc.,' Zool. vol. x.

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Curtis, H. E.
Dick, S. J.
Dobson, A. D., C.E., Westport
Elliott, C.
Farrelle, W. K., L.R.C.S.E.
Fell, C. Y.
Gabb, C. P.
Grant, A.
Greenwood, J. D., M.D., Motueka
Giles, Joseph, M.D., Westport
Huddleston, F.
Harley, Joseph
Harley, William
Hodgson, W. C.
Holloway, J.
Irvine, F. W., M.D.
Lee, Robert
Levastam, H. A.
Lightband, G. W.
Lowe, J. T.
Lucas, R.
Mackay, A.
Mackay, Joseph
Mackay, Thomas, C.E.
Monro, Sir David, M.D.
Moutray, J. C.
Renwick, The Hon. T.
Richardson, R.
Richmond, The Hon. J. C.
Rough, D.
Sadd, J. B.
Sclanders, A.
Sclanders, James
Sealey, W. B., M.D.
Shephard, J.
Simmons, F. C., M.A.Oxon
Smith, John
Squires, W. W., M.D.
Stafford, The Hon. E. W.
Suter, The Right Rev. A. B., D.D., Bishop of Nelson
Tatton, J. W.
Thorpe, The Rev. R. J., M.A.
Tomlinson, W.
Wakefield, Felix, F.L.S.
Webb, Joseph
Wells, William
Williams, George, M.D.